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**C&SF RESTUDY ALTERNATIVE EVALUATION TEAM REPORT
ON THE
PLAN FORMULATION ALTERNATIVE 3**

Prepared by the C&SF Restudy Alternative Evaluation Team

Introduction

The Central and Southern Florida (C&SF) Project Restudy created an Alternative Evaluation Team (AET) for the purpose of evaluating the effects from a number of alternative plans, as a basis for developing the Comprehensive Plan for the C&SF Project. The objective of the AET evaluation process is to identify the plan (or plans) which best meets the regional restoration and sustainability goals set by the authorizing legislation for the C&SF Project, and the Conceptual Plan of the Governor's Commission for a Sustainable South Florida. The optimum components in a Comprehensive Plan are identified by means of an iterative evaluation process, whereby different combinations of these components are sequentially modeled and evaluated relative to a set of pre-determined performance measures. Components which substantially improve on base conditions, or which meet performance targets, are carried forward in the iterative modeling and evaluation process, while components which fail to perform well may be modified or rejected.

The AET is an ad hoc team, established by the Restudy for the specific purpose of evaluating a large number of alternative plans during a definitive planning process. The plan evaluation process is scheduled for September 1997 through April 1998. This report presents a summary of the conclusions of the fourth plan evaluation meeting of the AET, held February 5-6, 1998. At this meeting, the AET evaluated the Alternative 3 model simulation (summarized below). The core of this report is a set of evaluations conducted by ten subregional and issue subteams of the AET, relative to Alternative 3, and recommendations from these subteams and the full AET for improvements in performance required during subsequent plan simulations. This report also includes recommendations for improvements in the plan evaluation process, for incorporation in future evaluation cycles.

Methods

The AET is a multi-agency, multi-disciplinary team, consisting of about 30 members. The AET is divided into ten subregional and issue subteams, each with a chair or co-chairs (Kissimmee / Lake Okeechobee, Lake Okeechobee Service Area, Lower East Coast, Northern / Central Everglades, Southern Everglades, Estuaries and Bays, Big Cypress, Total Systems, ATLSS / Threatened and Endangered / Keystone Species, and

Water Quality). During each evaluation cycle, each subteam has the lead responsibility for collecting all evaluations submitted to the AET from any non-AET source, which are applicable to the subregion and issues being addressed by that team; additionally, each subteam performs its own evaluations. The subteams synthesize all evaluations into subteam reports to the full AET during each evaluation cycle.

Plan evaluations conducted by the subteams and the full AET are based on, (1) a set of pre-determined, hydrological performance measures, and (2) output from landscape-scale, ecological and water quality models. Each performance measure identifies specific hydrological targets, based on ecological, water supply, flood control and water quality objectives established for the C&SF Restudy. These hydrological targets have been defined in large part through the development of a suite of conceptual ecological models for the south Florida wetland landscapes, the draft Lower East Coast Regional Water Supply Plan, and the Lake Okeechobee Regulation Schedule Study. Performance measures may be added or deleted from the set used by the AET, based on recommendations from the subteams and approval by the full AET. Each alternative plan is evaluated based on the success of that plan in meeting the targets established by the performance measures. The hydrological performance of each plan is reported on the public web site during each evaluation cycle.

In addition to the performance measures, the AET may use output from four landscape scale models, the Across Trophic Level System Simulation model (ATLSS), the Everglades Landscape Model (ELM), the Everglades Water Quality Model (EWQM), and the Lake Okeechobee Water Quality Model (LOWQM). These models will be used to compare effects from alternative plans against either the current base (1995) or future "without project" base (2050). Summaries of output from these models, as it becomes available to the AET, will be reported in the AET evaluation reports.

Evaluations submitted by a subteam to the full AET, whether originating from the subteam or from an outside evaluator, are framed within the context of one or more performance measures. The full AET, during its meeting, synthesizes the subteam evaluations into a set of summary, "highlights" statements. These highlights statements are intended to describe the major strengths and weaknesses of the plan under current review, relative to the targets set by the performance measures. The highlights statements are provided to the Alternative Development Team (ADT) as a basis for designing the next alternative plan.

In addition to the highlights report, the AET prepares a written report of each evaluation cycle. The written reports include short narrative summaries from each subteam, a list of the performance measures used by the subteams during that evaluation cycle, and recommendations for future plans and to the evaluation process.

Evaluation of Alternative 3

Plan Components

The following components are those which were included in the Alternative 3 hydrologic simulation by the South Florida Water Management Model (SFWMM). A more detailed description of the alternative can be found on the Restudy web site (www.restudy.org), Comprehensive Plan Evaluation, Alternatives Description / Evaluation.

Component A3. A Storage Reservoir (20,000 acres at 10' maximum depth) north of Lake Okeechobee.

Component B2. A Storage Reservoir (10,000 acres at 4' maximum depth) in the St. Lucie basin.

Component C1. Environmental Water Supply Deliveries to the St. Lucie Estuary (operational change only).

Component D3. A Storage Reservoir (20,000 acres at 8' maximum depth) with Aquifer Storage and Recovery (22 10-MGD wells) in the Caloosahatchee basin.

Component E1. Environmental Water Supply Deliveries to the Caloosahatchee Estuary (operational change only).

Component F1. Current Lake Okeechobee Regulation Schedule (with the exception of all but Zone A [emergency] regulatory releases to the St. Lucie Estuary).

Component G3. A Storage Reservoir (one 40,000 acre compartment at 6' maximum depth for supplying environmental demands and one 20,000 acre compartment at 6' maximum depth for supplying EAA irrigation demands) in the Everglades Agricultural Area with increased conveyance from Lake Okeechobee to the reservoir.

Component H1. Everglades Rain-Driven Operations (Draft Lower East Coast Regional Water Supply Plan Alternative 5 Operational Rules for deliveries to the Water Conservation Areas and Everglades National Park with the addition of triggers for Northeast Shark River Slough).

Component I3. Improved Conveyance between Water Conservation Area 3B and Everglades National Park (convert S-355 structures to pumps and bridge/elevate portions of Tamiami Trail below WCA-3B).

Component J. Not included in Alternative 2 or 3.

Component K2. Water Preserve Areas / L-8 Project Phase II in northern Palm Beach County – modified from Alternative 1 to capture additional water and improve stages in the West Palm Beach Water Catchment Area.

Component L3. Change Coastal Wellfield Operations in the Lower East Coast Service Area.

Component M3. Water Preserve Areas / Site 1 (1,660 acre at 6' maximum depth) with Aquifer Storage and Recovery (5 5-MGD wells) in western Palm Beach County.

Component N2. Water Conservation Area 2B Levee Seepage Management in Broward County to manage wet season seepage only.

Component O1. Water Conservation Area 3A and 3B Levee Seepage Management in Broward County.

Component P2. Water Preserve Areas / North New River Diversion Canal and Treatment Facility (1,600 acres at 4' maximum depth north of C-11) in Broward County with increased pump and structure capacities and seasonal S-141 operations.

Component Q1. Water Preserve Areas / Western C-11 Diversion Canal (to Central Lake Belt Storage) in Broward County.

Component R3. Water Preserve Areas / C-9 Impoundment (2,500 acres at 4' maximum depth) in Broward County.

Component S3. Central Lake Belt In-ground Storage Reservoir (4,000 acres) in Dade County.

Component T1. C-4 Structure in Dade County.

Component U3. Water Preserve Areas / Bird Drive Impoundment (2,877 acre at 4' maximum depth) in Dade County with operational rules for the C-4 downstream diversion structure.

Component V2. L-31N Levee Improvements for Seepage Management in Dade County with additional reduction of seepage in the wet season.

Component W2. Taylor Creek / Nubbin Slough Storage and Treatment Area (5,000 acre storage area at 10' maximum depth and 5,000 acre stormwater treatment area at 4' maximum depth).

Component X3. Water Preserve Areas / C-17 Backpumping in North Palm Beach Service Area (550 acre stormwater treatment area at 4' maximum depth).

Component Y3. Water Preserve Areas / C-51 Backpumping to Water Catchment Area in Palm Beach County (600 acre stormwater treatment area at 4' maximum depth).

Component AA3. Additional S-345 Structures in L-67A in Water Conservation Area 3B.

Component BB2. Improvement to Dade-Broward Levee and Associated Conveyance System in Dade County.

Component CC3. Broward County Secondary Canal System (increase pump capacity and canal conveyance in C-12 and C-13).

Component DD3. Revised Holey Land Operational Plan (based on rain-driven operations) in Palm Beach County.

Component EE3. Modified Rotenberger Regulation Schedule (based on rain-driven operations) in Palm Beach County.

Component FF3. Construction of S-356 A & B Structures (L-31N along east side of Northeast Shark River Slough) in Dade County.

Component GG. Lake Okeechobee Aquifer Storage and Recovery (100 10-MGD wells) along the lake peripheral levee.

Component HH3. Operation Change of S-343 A & B (closed during the January to June time period) in Dade County.

Component II3. Pump Station G-404 Modification in Palm Beach County.

Component JJ3. Loxahatchee National Wildlife Refuge Rainfall-Driven Operations in Palm Beach County.

Component KK3. Loxahatchee National Wildlife Refuge Internal Canal Structures to improve timing and location of water depths in the Refuge in Palm Beach County.

Component LL3. C-51 Regional Groundwater Aquifer Storage and Recovery (34 well clusters) in Palm Beach County.

Component MM3. Hillsboro Canal Basin Regional Aquifer Storage and Recovery (37 well clusters) in Broward and Palm Beach counties.

Component NN3. North New River Regional Groundwater Aquifer Storage and Recovery (25 well clusters) in Broward County.

Component OO3. Reduce Wet Season Flows to South Dade in Southern Portion of L-31N and C-111 to increase deliveries to Northeast Shark River Slough in Dade County.

Component PP3. Backpumping of the C-7 Basin to the Central Lake Belt In-ground Storage Reservoir via the C-6 Canal in Dade County.

Alternative 3 Highlights

The following highlights represent the major strengths and weaknesses of Alternative 3, as evaluated by the AET:

AET TOP 10 LIST FOR ADT TO ADDRESS

1. Reduce lake-triggered water shortages in the Lower East Coast Service Areas and supply-side management cutbacks (from eight to three). No event should be longer than seven consecutive months.
2. WCA-3A / 3B / Rotenberger: Raise trigger to achieve increase in south-central 3A levels above NSM by 0.2 ft in the dry season and 0.5 ft in the wet season. Deliver more water to south-central 3A via additional inputs & stages in NW 3A, and via releases from Rotenberger to keep depths <1.5 ft. Minimize high water peaks occurring in 1994-95 in southern 3A and 3B. Decentralize Miami Canal, L-67 A & C.
3. Cape Sable Seaside Sparrow Indicator Region: Dry out the indicator region more during wet years (89, 94-95); redirect flows to NESRS.
4. NESRS / Rocky Glades / Florida Bay: Increase water deliveries via NESRS during January and February. Compensate for seepage loss across L-31N by increased inputs.
5. Biscayne Bay / Miami-Dade County: Dade County - Raise ground water levels / canal levels at C-2 / C-4. Protect western Dade from flooding. Biscayne Bay - Increase dry season surface water inflows by 30%.
6. Broward County: Raise ground water levels/canal levels, C-9 / C-11 / C-12.
7. Try to incorporate C-23 / C-24 / North Fork / South Fork storage (WPAs).
8. Maximize decentralization. Incorporate more passive conveyance into the components.
9. Improve WCA-2A timing (reduce wet year highs in the south and dry season lows in north).
10. Increase dry season deliveries in Model Lands for Indicator Regions 5 and 6.

A. Total System

Performance Indicator: Hydroperiod Distribution.

Goal/Target: Generally, match the proportions and patterns of NSM.

Performance: NSM in dry years (reference the 1989 map) shows five surviving long-hydroperiod core areas linked by intermediate hydroperiod class wetlands.

Improvement Needed: Support dry year pools. Shift more water to areas mentioned below, but particularly to the sloughs in the park.

Recommendations: Several dry-year long-hydroperiod cores could be supported by:

1. allowing longer hydroperiods in either north or east Loxahatchee (only if Loxahatchee National Wildlife Refuge approves).
2. increasing hydroperiods in a focused set of cells in northwestern WCA-3A rather than have long-hydroperiod cells spread across the northern boundary.
3. deciding if eastern WCA-3A or WCA-2B should or could take the place of an area originally east of the levee.
4. breaking the big pool around L-67 in two and increase hydroperiods in the sloughs to create another dry year pool.

Note: Does documentation exist that supports this recommendation?

Performance Indicator: Hydroperiod Improvement.

Goal/Target: Minimize acreages with too short or too long hydroperiods.

Performance: Alternative 3 is much better, but in Loxahatchee, WCA-3B, and Rotenberger the number of acres "improved" is actually smaller than the area now exceeding NSM by 7 to 30 days. WCA-2A, WCA-2B and Holey Land are close behind. Rotenberger and Holey Land both have greater areas with shortened hydroperiods than areas improved.

Improvement Needed: The park looks good overall but the sloughs could still use longer hydroperiods. Unless it is decided to select areas to serve as dry season pools, reduced hydroperiods in areas where water is pooling is needed. Rotenberger, Holey Land, and Pennsuco shortened hydroperiods increased and flooded areas were allowed to dry down.

Recommendations: Increase conveyance into northwest WCA-3A if that would help the areas north of there.

Performance Indicator: Ponding Depth and Depth Differences map and histograms.

Goal/Target: General NSM depths patterns.

Performance: The following locations are almost the same as the areas with excessive hydroperiods:

1. One class too deep (0.5 to 1.0 ft higher than NSM):
 - south end of Loxahatchee,
 - south end of WCA-2A,
 - eastern WCA-3A
 - both sides of upper half of L-67.
2. Two classes too deep (1.0 to more than 2.0 ft higher):
 - WCA-2B.

Improvement Needed: Lower water elevations in WCA-2B. Even if a long hydroperiod could make it a suitable dry year refuge, depths are excessive.

Recommendations: Improve conveyance through L-67 so that the deeper water area ends up south of Tamiami Trail in the sloughs.

Notes: May wish to alter depth requirements for WCA-2B some to mimic the area east of the levee that is now gone. (see Annual Average Ponding Depth and May Average Ponding depth for NSM).

B. Kissimmee / Lake Okeechobee Subregion

Performance Measure: Number of stage events >17 ft.

Goal: No events.

Note: Alternative 3 reduced the number of events to three; this compares favorably with Alternative 2 (four events), the 2050 base (five events) and the 1995 base (six events).

Recommendation: Maintain the features that led to this improvement.

Performance Measure: Number of stage events >15 ft lasting > 6 months.

Goal: No events.

Notes: Alternative 3 reduced the number of events to three; this compares favorably with Alternative 2 (six events), the 2050 base (six events), and the 1995 base (seven events).

Alternative 3 also had a median duration that was well below six months.

Recommendation: Maintain the features that led to this improvement.

Performance Measure: Number of stage events <12 ft lasting >6 months.

Goal: No events.

Performance: Alternative 3 reduced the number of events to five; this compares favorably with Alternative 2 (seven events) and the 2050 Base (eight events), but exceeds the 1995 Base (three events). The median duration of events under Alternative 3 was well below six months, lower than under all other scenarios.

Recommendation: No specific recommendations; generally a positive result.

Performance Measure: Number of stage events <11 ft.

Goal: No events.

Note: Alternative 3 reduced the number of events to six; this compares favorably with Alternative 2 (nine events), the 2050 base (12 events), and the 1995 base (eight events).

Recommendation: Maintain the features that led to this improvement.

C. Lake Okeechobee Service Area

Performance Measure: Frequency of Water Restrictions for the 1965 – 1995 Simulation Period for the Lake Okeechobee Service Area.

Goal: Total number of water restriction events (years with restrictions) should be three or less in the simulation period. An event should last no longer than seven consecutive months.

Performance: Years with water restrictions were ten in the 1995 Base and increased to 15 in the 2050 Base. They were only reduced by three events to 12 in Alternative 2. In Alternative 3 they were reduced another four events to eight. In Alternative 3, two of the events last nine months.

Recommendations: Under present simulation rules, the key to further reductions in water shortages in the Lake Okeechobee Service Area is maintaining higher stages in the lake during dry periods. Recommendations for consideration are:

1. Investigate whether a healthy Caloosahatchee Estuary can be produced with less total flows than are presently being simulated as target flows. They average more than 600,000 acre feet per year. Reducing such flows would allow the Caloosahatchee reservoir and ASR system to meet more demands and reduce demands on Lake Okeechobee. Consider backpumping some of any excess flows to Lake Okeechobee after appropriate quality treatment.
2. Raise the lake regulation schedule. In Alternative 2, significant portions of the regulatory releases that are captured are quickly passed into the Everglades Protection Area. A higher allowable lake schedule would keep some of these waters in the lake and should reduce some of the high flow events into the Everglades Protection Area.
3. Increase north of the lake storage. This would help much in the same way as the higher lake schedule. Cost versus environmental tradeoffs would need to be investigated.
4. Expand ASR and other storage systems in the Lower East Coast Service Areas. In Alternative 2, these areas receive significant surface deliveries from the Everglades Protection Area and from Lake Okeechobee. The ASR system in Service Area 1, which was part of Alternative 2, showed the potential for storage in the coastal basins to reduce demands for surface deliveries. Determine where these deliveries are being made; determine whether there are excess wet season/wet period flows to tide in these or nearby basins and, if there are, implement cost-effective storage measures to reduce these demands.

Performance Measure: EAA Water Budget (Runoff Backpumped to Lake Okeechobee).

Goal: Maintain existing levels of flood protection.

Note: Backpumping to Lake Okeechobee occurs only when flood waters reach threatening levels. Maintenance or reduction of backpumping indicates flood protection is being maintained. A more discerning performance measure is still being developed. There is no indicated problem. Backpumping in Alternative 3 is less than in the 1995 Base.

D. Lower East Coast Subregion

Water Supply:

Performance Measure: Frequency of Water Restrictions for the 1965 - 1995 Simulation Period for the Lower East Coast Service Areas.

Goal: Three events during the simulation period, each event no longer than seven consecutive months.

Performance: Alternative 3 is an improvement over all previous runs by reducing the number of events. However, the five shortage events triggered by Lake Okeechobee stages for the Lower East Coast Service Area is unacceptable.

Improvement Needed: Reduce the number of local ground water and lake triggered cutbacks to a 1 in 10 level of certainty.

Recommendations: More water needs to be made available from Lake Okeechobee to avoid water shortages. Another option would be to remove, or alter the Lake Okeechobee trigger for Lower East Coast cutbacks since the dependence of the Lower

East Coast Service Area on average annual deliveries from the regional system generally declines across the alternatives compared to the 1995 Base. Some water is now supplied by the regional ASR system during dry seasons.

Performance Measure: Frequency and Severity of Water Restriction Triggers for the 1965 - 1995 Simulation Period for the North Palm Beach Service Area.

Goal: Reduce the frequency of local and Lake Okeechobee water restriction events to no more than three events for the 31-year period of record to meet a 1 in 10 level of certainty.

Performance: There is no problem with locally triggered events. The frequency of Lake Okeechobee shortage events is too high.

Improvement Needed: Reduce the number of local ground water and lake triggered cutbacks to a 1 in 10 level of certainty (no more than three events for the period of record).

Recommendation: The number of locally triggered events has been reduced to zero. Moving the Riveria wellfields has helped. More water needs to be made available from Lake Okeechobee.

Note: Please identify where the new demands are located.

Performance Measure: Frequency and Severity of Water Restriction Triggers for the 1965 - 1995 Simulation Period for Service Area 1.

Goal: Reduce the frequency of local and Lake Okeechobee water restriction events to meet a 1 in 10 level of certainty (no more than three events for the 31-year period of record).

Performance: Only one shortage event for the period of record was caused by local trigger wells. The frequency of events caused by Lake Okeechobee is too high. The Water Catchment Area is not performing as well as it could; it dries out more frequently than the Loxahatchee Slough.

Improvement Needed: Reduce the number of local ground water and lake triggered cutbacks to 1 in 10 level of certainty (no more than three events for the period of record).

Recommendation: Make more water available from Lake Okeechobee. Also, add ASR to Component K2 to improve performance of the Water Catchment Area.

Performance Measure: Frequency and Severity of Water Restriction Triggers for the 1965-1995 Simulation Period for Service Area 2.

Goal: Reduce the frequency of local and Lake Okeechobee water restriction events to meet a 1 in 10 level of certainty (no more than three events for the 31-year period of record).

Performance: Twelve shortage events for the period of record are caused by local trigger wells. The frequency of events caused by Lake Okeechobee is also too high (five events). Pompano, Hollywood, Ft Lauderdale Airport, and North Lauderdale are causing the cutbacks. Hollywood and Ft Lauderdale Airport are the most problematic. Moving Hollywood's pumpages has helped. The number of months has been reduced from 40 in Alternative 2 to 25 in Alternative 3, but moving the pumpages has not solved the problem.

Improvement Needed: Reduce the number of local ground water and Lake Okeechobee triggered cutbacks to a 1 in 10 level of certainty (no more than three events for the period of record).

Recommendation: Make more water available from Lake Okeechobee. The ADT needs to either add seepage to send ground water south and east to recharge wellfields and the C-9 and North New River canals or move it south to ENP. The Pompano trigger well experiences five locally triggered cutbacks. Pompano also currently experiences saltwater intrusion problems in its wellfields. The easternmost pumpages should be moved to the North County Regional Wellfield in Alternative 4.

Performance Measure: Frequency and Severity of Water Restriction Triggers for the 1965 - 1995 Simulation Period for Service Area 3.

Goal: Reduce the frequency of local and Lake Okeechobee water restriction events to meet a 1 in 10 level of certainty (no more than three events for the 31-year period of record).

Performance: Seven shortage events for the period of record are caused by local trigger wells. The wells causing problems in Service Area 3 are Homestead (14 times), Florida City (one time), Cutler Ridge (two times), North Miami (1 time), Miami (two times), and Taylor (five times). The number of wells affected has increased from three in Alternative 2 to six wells in Alternative 3. In addition, there are five Lake Okeechobee triggered events for Service Area 3.

Improvement Needed: Reduce the number of local ground water and lake triggered cutbacks to a 1 in 10 level of certainty (no more than three events for the period of record).

Recommendation: Make more water available from Lake Okeechobee. Mound water or increase ground water seepage for Miami-Dade County.

Canal Levels:

Performance Measure: % of Time Canal Stage less than Saltwater Intrusion Criteria and Occurrences greater than one Week for the North Palm Beach Service Area.

Goal: Reduce the amount of time and number of occurrences the canal does not meet saltwater intrusion criteria to zero.

Performance: All canal levels meet or exceed the saltwater intrusion criteria.

Performance Measure: % of Time Canal Stage less than Saltwater Intrusion Criteria and Occurrences greater than one Week for Service Area 1.

Goal: Reduce the amount of time and number of occurrences the canal does not meet saltwater intrusion criteria to zero.

Performance: All canal levels meet or exceed the saltwater intrusion criteria.

Performance Measure: % of Time Canal Stage less than Saltwater Intrusion Criteria and Occurrences greater than one Week for Service Area 2.

Goal: Reduce the amount of time and number of occurrences the canal does not meet saltwater intrusion criteria to zero.

Performance: The C-9 and C-14 canals do not meet the goal. The C-14 experiences minor drops in water levels (2% of the time). The C-9 drops below the saltwater intrusion criteria 5% of the time, which is better than Alternative 2.

Improvement Needed: More water deliveries need to be made to the C-9 and C-14 canals or there needs to be greater ground water seepage.

Recommendation: The stage duration curves show that approximately half of the time, ground water levels for all alternatives are at a height which is at or just above the saltwater intrusion trigger level. Both the 1995 Base and 2050 Base have ground water levels that more than half of the time are at least a few inches higher than the saltwater intrusion triggers. The difference of a few inches in hydraulic head may be sufficient to provide more freshwater deliveries to Biscayne Bay via ground water and the aquifer near the Hollywood wellfields. Alternatives that support higher ground water levels to prevent saltwater intrusion and trigger shortages are necessary.

Performance Indicator: Mean wet/dry Season Flows to Pond Apple Slough through C-11@S-13 for the 31-year simulation.

Goal: Provide enough water to prevent saltwater intrusion of Pond Apple Slough. Flows should be greater than 1995 Base flows and flows should be greater in the wet season.

Performance: Flows over S-13 and S-13A are reduced by half and to zero, respectively, diminishing the water supplied to Pond Apple Slough. Rehydration of the slough is a joint project of the SFWMD and Broward County - DNRP.

Improvement Needed: More flows need to be sent east in C-11 to the slough.

Recommendation: Modify the operation of the C-11 Reservoir to provide more flows east.

Performance Indicator: Mean wet/dry Season Flows to North Fork of New River C-12@S-33 for the 31-year simulation.

Goal: Provide enough water to prevent saltwater intrusion of North Fork of the New River. Flows should be greater than 1995 Base flows and flows should be greater in the wet season.

Performance: Flows over S-33 remain constant on all runs. It has been documented by Broward County - DNRP that additional flows are necessary to prevent saltwater intrusion. Restoration of the North Fork of the New River is a Critical Project of the USACE and is sponsored by DNRP.

Improvement Needed: More flows need to be sent east in C-12 to the North Fork.

Recommendation: Provide more flows east in C-12.

Performance Measure:: % of Time Canal Stage < Saltwater Intrusion Criteria and Occurrences >1 Week - Canal C-6 at S-26, C-4 @S-25B, and C-2@S-22.

Goal: Reduce the amount of time and number of occurrences the canal does not meet saltwater intrusion criteria to zero.

Performance: Alternative 3 shows a decrease in the number of saltwater intrusion trigger events relative to Alternative 2 for the C-6. The canal is below the criterion only 4% of the time. Alternative 3 shows a significant increase in the number of saltwater intrusion trigger events relative to Alternative 2 for the C-4. The canal is below the criterion 27% of the time. Alternative 3 shows a significant increase in the number of saltwater

intrusion trigger events relative to Alternative 2 for the C-2. The canal is below the criterion 21% of the time.

Improvement Needed: More flows need to reach the end of the system.

Recommendation: Fix constraints in the local and regional systems.

Performance Indicator: Stage duration curves for C-100A, C-100B, C-102N, C-103, C-111, C-103S, C-102, and C-1.

Performance: Many of the South Miami-Dade County canals' water levels have declined or shown no improvement in Alternative 3. C-100A, C-103, and C-1 have declined in water level performance with respect to the 1995 Base. C-100B, C-102N, and C-102 have shown no improvement with respect to the 1995 Base. The lack of water supply to these canals is possibly resulting in the triggering of water shortages in South Miami-Dade. Additional water should be put into these canals to reduce these water shortages.

Improvement Needed: Meet or exceed the 1995 Base. Restore wet season flows.

Reservoirs:

Note: STAs for components Y3 and X3 in C-51 and C-17 basins may be placed on sensitive wetlands. The ADT may want to reconsider placement.

Performance Indicator: Stage duration curves for Site 1 Reservoir.

Performance: Even with the addition of ASR, less water is available from the reservoir than in Alternative 2. The reservoir is dry 30% of the time and the duration curve is much lower than in Alternative 2.

Note: How cost effective is the reservoir and ASR? Could ASR replace the above ground reservoir? Also, how risky is it to rely so heavily on ASR?

Performance Indicator: Stage duration curves for C-11 Reservoir.

Performance: Performs the same as in Alternative 2. Too much water is going west.

Recommendation: Send more water east to Pond Apple Slough.

Performance Indicator: Stage duration curves for C-9 Reservoir.

Performance: The reservoir is dryer 20% of time compared to Alternative 2. Too much water may be going west.

Recommendation: Send more water east to wellfields and keep C-9 above saltwater intrusion criteria.

Performance Indicator: Stage duration curves for Bird Drive Reservoir.

Performance: The Bird Drive Basin Impoundment appears incapable of preventing saltwater intrusion in the C-2 and C-4 canals. Operation of this impoundment needs to be reexamined and/or more water needs to be routed from the regional system to hold consistently higher levels in these canals. The stage duration curve exceeds ground elevation only 5% of the time.

Improvement Needed: The ADT needs to correct how the component operates and how the model is calibrated for this area.

Recommendation: The ADT needs to address water quality concerns. This facility is located within the West Wellfield Interim Protection Area and, therefore, only water of the appropriate quality should be backpumped into this facility.

Performance Indicator: Stage duration curves for Central Lakebelt Reservoir.

Performance: The Central Lakebelt Storage described in Alternative 3, Component Map 6 has only 100,000 acre feet of storage, of which perhaps half, or 50,000 acre feet, is available because of evaporation. This could potentially supply 44 MGD to meet all demands. It is apparent that there are too many demands on this reservoir and its storage is inadequate, particularly in view of the increase in the potential for saltwater intrusion in Alternative 3 for C-2 and C-4. It is also unclear as to how other lakes within the Lake Belt will function within this overall plan in providing additional storage. It is very clear from Alternative 3, however, that additional storage or water supply from the regional system is needed.

Improvement Needed: The ADT needs to correct how this component operates.

Recommendation: Enlargement of this reservoir to the north of the C-6 Canal appears necessary to provide enough effective storage.

Note: In Alternative 4 a performance indicator for the Northwest Wellfield and the cell to the east of the Northwest Wellfield located at R25C29 and R25C30, respectively, showing stage hydrographs and monthly percent duration curves for each alternative should be included. Likewise this should also be run for the West Wellfield at R21C27 (this location should be checked), and for the Bird Drive Basin Impoundment. A new Miami-Dade County wellfield has been included in these alternative runs in the southwest county, and the location of this wellfield needs to be identified with performance indicators run for it as recommended above.

Discharges To Tide:

Performance Indicator: Mean Annual Surface Flows Discharge to Tide from the Lower East Coast Service Area for the simulation period.

Performance: For Alternative 3, there is a trend from north to south of decreasing discharges to tide while failure to meet saltwater intrusion criteria increases. Discharge to tide in the North Palm Beach Service Area remains constant when compared to the 1995 Base and saltwater intrusion criteria for major canals is met. For Service Area 1, there is a 45% average annual decrease (361k acre-feet/yr) in discharges to tide when compared to the 1995 Base and the saltwater intrusion criteria for major canals is met. For Service Area 2, discharges to tide decrease approximately by 29% (137k acre-feet/yr) on average compared to the 1995 Base, while two canals, C-9 and C-14, were unable to meet their saltwater intrusion criteria. In the case of Service Area 3, there is a 42% decrease in discharges to tide on average (410k acre-feet/yr) when compared to the 1995 Base, while all of the primary canals fail to meet their saltwater intrusion criteria and many of the smaller canals go dry. The total reduction in discharges on average is 928,000 acre-feet ~1 million acre feet.

Improvement Needed: Maintain stages higher to prevent saltwater intrusion without compromising flood protection. Some losses from the system will remain.

Water Deliveries;

Performance Indicator: Number of days and volume Lower East Coast Service Area Water Supply Deliveries were made from Lake Okeechobee for the simulation period.

Performance: The number of days water deliveries were made to the Lower East Coast Service Area from the regional system increase by 10% to 50% for all of the service areas in Alternative 3 when compared to the 1995 Base. But the volume of water supplied on average has declined when compared to the 1995 Base for Service Area 1 by 50%, increases for Service Area 2 by 200%, and increases for Service Area 1 slightly. Is the Central Lake Belt reservoir able to provide the 60+k acre-feet no longer provided by the regional system? This reservoir may not be performing as well as it could since canal levels are low and there are many local ground water trigger events. During drought events, deliveries have declined for Alternative 3 when compared to Alternative 2.

However, the Lower East Coast Service Areas are more dependent on the regional system in Alternative 3 than in the 1995 Base. During wet years, the service areas have gained some self-sufficiency, but they are still dependent on the regional system during drought events. The decline in deliveries can also be seen in the decline in flows to Biscayne Bay.

Improvement Needed: Reduce the number of local ground water and Lake Okeechobee triggered cutbacks to 1 in 10 level of certainty (no more than three events for the period of record). Increase flows to Biscayne Bay. Maintain canals above saltwater intrusion criteria.

Recommendations: Increase deliveries to Service Areas 2 and 3 as needed (or increase ground water seepage).

Flood Protection:

Performance Indicator: Stage Hydrographs for R10C25, R17C27, and R15C26.

Performance: The stage hydrographs indicate an increase in flooding potential when comparing Alternative 3 to the 1995 Base, and 2050 Base. The 2-foot root zone is exceeded 21 to 62 times for these cells.

Improvement Needed: Capture enough seepage to avoid exceeding the 2-foot root zone during the growing season while not diminishing flows to Biscayne Bay.

Recommendations: Capture wet season seepage from L-31N moving east into the agricultural areas.

Performance Indicator: Stage Hydrograph for R19C27.

Performance: The stage hydrograph indicates no change in the flooding potential when comparing Alternative 3 to the 1995 Base. However, the 2-foot root zone is exceeded excessively.

Improvement Needed: Avoid exceeding the 2-foot root zone during the growing season.

E. Northern / Central Everglades (WCAs, Holey Land, Rotenberger) Subregion**Loxahatchee National Wildlife Refuge (WCA-1):**

Performance Measures: Hydroperiod Difference Map and Indicator Region graphics (e.g., inundation duration summary table, high water/low water summary table, stage duration graphics, temporal variation in weekly stages graphics for Indicator Regions 26 & 27).

Planning Targets: Match NSM Targets; minimize high/low criterion exceedence.

Performance: Although Alternative 3 does a good job of mimicking NSM hydroperiods, Loxahatchee National Wildlife Refuge still has some problems with deep water ponding at the southern portion of the refuge. Also, the water cost for maintaining rainfall-driven, NSM-like hydroperiods in WCA-1 is roughly 100,000 acre-feet/year from Lake Okeechobee.

Improvement Needed: Based on existing performance measures, there is a need to decrease ponding in southern Loxahatchee National Wildlife Refuge to better match NSM conditions.

Recommendation: The AET needs to discuss issues related to water supply trade-offs between areas, water quality issues, and appropriate targets for Loxahatchee National Wildlife Refuge. If NSM conditions are desired, the team should continue to utilize the rainfall-driven water deliveries to WCA-1 as part of the regional restoration strategy for the Everglades.

Northern WCA-3A, Holey Land and Rotenberger WMAs:

Performance Measure: Extreme Low Water (Indicator Regions 20-22, 28, 29).

Planning Target: Minimize dry-outs below -1.0 ft.

Performance: Alternative 3 shows improvement over Alternative 2 in WCA-3A north, but the frequency of marsh dry-outs is still greater than the target of zero and greater than NSM within Indicator Regions 20 and 22. In Region 21, there were 11 low water events compared to NSM's 17 events; however, it is desirable to minimize extreme drying in this region to protect peat soils from further oxidation and soil subsidence. In the Holey Land Wildlife Management Area, the frequency of low water periods increased from nine events in Alternative 2 to 13 events in Alternative 3. In Rotenberger Wildlife Management Area the frequency of low water periods increased from 11 to 17 events between Alternatives 2 and 3, although average duration showing a slight decrease (from eight to seven weeks). Note that the recommendation for Alternative 2 had been to reduce depths in these areas without increasing the frequency of extreme low water.

Improvement Needed: Although it may not be possible to "drought-proof" the region, there is a need to decrease the number and duration of low water events to protect already impacted peat soils.

Recommendations: Increase dry season inputs of water into western WCA-3A and/or increase storage to north.

Holey Land and Rotenberger WMAs:

Performance Measure: Extreme High Water.

Planning Target: Minimize events over 1.5 ft criterion and exceedence of NSM high stages.

Performance: Rotenberger exceeds 1.5 ft 10% of the time (16 events averaging nine weeks each), whereas NSM exceeds the criterion 8% of the time (17 events averaging seven weeks). Holey Land exceeds 1.5 ft 17% of the time (24 events averaging 11

weeks), whereas NSM exceeds the criterion 15% of the time (19 times averaging 12 weeks). Both areas, however, are greatly improved over the 2050 Base.

Improvement Needed: Decrease the frequency of high stages.

WCA-2A:

Performance Measures: Review of inundation summary tables, high/low water summary tables, stage duration, and temporal variation in weekly stage graphics for Indicator Regions 25 & 24.

Planning Targets: Match NSM Targets; minimize high/low criterion exceedence.

Performance: Extreme peak water depths exceed 2.5 ft during several of the wettest years; NSM does not exceed 2.5 ft. Alternative 3 is similar to the 2050 Base but is deeper than the 1995 Base case. Regarding Extreme Low Water in northern WCA-2A (Region 25), there are fewer occurrences of low water than NSM or Alternative 2 (seven low water events for Alternative 3 vs. 11 for NSM and Alternative 2). However, to the south (Region 24), water depths are less than -1.0 ft below ground on ten occasions for Alternative 3 as compared to five times for NSM. Alternative 3 is similar to Alternative 2 (nine events) and the 2050 Base (eight events) but is an improvement over the 1995 Base (12 events). Regarding Timing of Depth Variation in northern WCA-2A, water depths increase earlier in the wet season and recede faster in the dry season as compared to NSM. In the south, mean wet season high water is ~ 0.5 ft higher than NSM, but mean dry season low water matches NSM. This pattern is similar to the 2050 Base but is somewhat deeper than the 1995 Base. Year-to-year standard deviation is improved over the 2050 Base and Alternative 2, but still exceeds NSM.

Improvement Needed: As previously recommended for Alternative 2, there is a need to lower water levels (~0.4 ft) during above normal rainfall years to protect remaining tree island communities, and a need to reduce the frequency of extreme low water events.

Recommendation: Adjust water level triggers within WCA-2A.

South Central WCA-3A (Indicator Region 17):

Performance Measure: Inundation Duration.

Planning Target: Match NSM.

Performance: The average hydroperiod of Alternative 3 (88%) matches NSM.

However, in Region 17 the NSM hydroperiod appears to be too short for a ridge and slough landscape (89%); thus by matching NSM, Alternative 3, like Alternative 2, over-drains this area.

Performance Measure: Extreme Low Water.

Planning Target: Minimize events below -1.0 ft .

Performance: Region 17 dries out to <-1.0 ft the same percent of time as NSM, but longer than the 1995 Base (~3% vs. 1% of time); this area is considered the least hydrologically damaged part of the WCAs, so further drying should be avoided.

Improvement Needed: This is the same recommendation as for Alternative 2. There is a need to increase depths in Region 17 by about 0.2 ft in the dry season and 0.5 ft in the wet season.

Recommendation: Adjust NSM trigger at 3A-4 gage .

Southern WCA-3A and WCA-3B:

Performance Measure: Extreme High Water (vs. 2.5 ft criterion and NSM annual peaks).

Planning Target: Minimize depths > 2.5 ft to protect tree islands and minimize depths in excess of NSM annual high water.

Performance: In Alternative 3, Indicator Region 14 depths exceed 2.5 ft on ten occasions for an average of eight weeks per event, whereas NSM exceeds 2.5 ft only once for three weeks. This is a slight increase in the percent of time compared to Alternative 2. During the 1994-95 high water period, Alternative 3 had sustained depths of 3-4 ft in Region 14, whereas NSM exceeded 2.5 ft only briefly in 1994. Although this is an improvement over the 2050 Base and over Alternative 2, it is a major restoration concern because of potential damage to tree islands. Similar but less extreme flooding happens throughout WCA-3A (all Indicator Regions except 22), and in WCA-3B (Indicator Region 15). Note that during this time depths reached but did not exceed NSM levels in Shark River Slough.

Improvement Needed: Eliminate extreme high water during 1994 and 1995 simulation periods.

Recommendation: Remove impediments to flow and/or capture flood waters.

Overall Northern and Central Everglades:

Performance Measures: May ponding depth maps and peak stage difference maps.

Planning Target: Restore NSM landscape pattern:

1. Deepest water (< 2 ft in dry season) on the east side of the system.
2. Connected dry season refugia for aquatic animal movement.
3. Full range of hydrologic gradient as foraging habitat for wading birds.

Performance: There is more connectivity of dry-season refugia in Alternative 3 than in other alternatives but it is still less than NSM. A smaller proportion of the overall system has ponding (deep-water refugia) in the 1-2 ft range than does NSM. Dry season refugia in WCA-1, WCA-2A, and WCA-3A occur along levees, as in the other alternatives and bases; however, WCA-1 is more like NSM in Alternative 3 than in other alternatives. Dry-season refugia in WCA-2A and 3A are restricted to levee edges and are disconnected from each other. This may reduce the area of marsh that aquatic organisms can disperse to after seasonal re-wetting. In WCA-3B, Alternative 3 has a larger area of dry-season refugia than other alternatives but peak stage differences when compared to the 1995 Base show increased risk of flooding tree islands. WCA-3B may be connected hydrologically to NE Shark Slough but still does not allow for movement of aquatic animals from Shark Slough into WCA-3B because of structure design.

F. Southern Everglades (Everglades National Park, Model Lands)**Exotics:**

Performance Measures: Ecological: Native and introduced aquatic organisms in canals. Hydrological: Ponding depth differences SFWMM v. 3.4 relative to NSM v. 4.5; 1989 hydroperiod differences Alternative 3 SFWMM v. 3.4 relative to NSM v. 4.5.

Goal: Match NSM characteristics of the system.

Performance: Ponding during wet and dry seasons, and overdrainage, with concomitant negative effects on freshwater aquatic communities. Increased dispersal by introduced plants and animals, and altered energy flow patterns in adjacent wetlands.

Improvement Needed: Restoration of sheet flow to the historical central flow way of the southern Everglades and short-hydroperiod marshes to the east and west of this central flow way.

Recommendation: Decompartmentalization.

Structural/Operational Changes: Eliminate impounded flows within the northern reaches of the catchment area and between these impounded marshes and downstream reaches by the removal of internal levees, the causewaying of roads traversing interior marshes, etc.

Rocky Glades:

Performance Measures: Ecological: Marl prairie; Bayhead tree island; Aquatic organisms in the Rocky Glades; Amphibians and reptiles in the East Everglades Rocky Glades. Hydrological: Temporal variation in mean weekly stage for rockland marl marsh (Indicator Region 8); Normalized weekly stage duration curves for rockland marl marsh (Indicator Region 8).

Goal: Match NSM.

Performance: The Rocky Glades still has considerably lower stages, particularly in the dry season, compared to NSM. There are also too many drydown events.

Improvement Needed: Provide longer continuous hydroperiods, greater ponding depths, and more frequent occurrences of multi-year continuous inundation. Reduce frequency of occurrence of water levels that fall –1 ft or greater below ground surface.

Recommendation: Restoration of more natural hydropatterns in this area, resulting in a suite of ecological benefits for aquatic communities and endangered species, is recommended.

Structural/Operational Changes: Maintain adjacent canal stages at high enough levels that would result in the improvements needed. Buffers???

Shark River Slough:

Performance Measures: Ecological: Tree island hammocks; Peat-forming communities; Average water depth during peak alligator mating period in Shark Slough; Freshwater fishes and invertebrates; Amphibians and reptiles in Shark River Slough westernmost edge of Rocky Glades. Hydrological: Inundation duration summary (Indicator Region 10); Normalized weekly stage duration curves mid-Shark River Slough (Indicator Region 10).

Northeast Shark Slough:

Performance Measures: Ecological: Tree island hammocks; Peat-forming communities; Average water depth during peak alligator mating period in Shark Slough; Freshwater fishes and invertebrates. Hydrological: Inundation duration summary (Indicator Region 11); Normalized weekly stage duration curves for Northeast Shark River Slough (Indicator Region 11).

Goal: Match NSM.

Performance: Flood releases, reduced hydroperiods.

Improvement Needed: Rainfall-based flows must extend from the upper to the lower reaches of the Everglades catchment area in sufficient volume to maintain dry season pool formations that persist within the downstream reaches of the system, with hydropatterns similar to those predicted by NSM. Uninterrupted sheet flow is needed, as opposed to limited point source introductions, e.g., pumps.

Recommendation: Explore using the lowest management intensive strategy to establish rainfall-based flows. Incorporate seepage control strategies, such as buffer lands, sufficient to restore NSM-like conditions in Northeast Shark Slough.

Structural/Operational Changes: Restore sheet flow in Northeast Shark Slough without the use of pumping stations.

G. Estuaries and Bays

Caloosahatchee Estuary:

Performance Measure: The number of times salinity envelope criteria were not met for the Caloosahatchee Estuary.

Goal: A base flow of 300 cfs is needed to maintain appropriate salinities.

Performance: The number of minimum flow violations is only one month away from the target (60).

Performance Measure: The number of times high discharge criteria (mean monthly flow > 2,800 and 4,500 cfs) were exceeded for the Caloosahatchee Estuary.

Performance:

Performance Measure: Regulatory releases from Lake Okeechobee.

Goal: None are desired.

Note: There is only one regulatory release which is a great improvement!!!!

Recommendations: Overall, in Alternative 3 the Caloosahatchee is almost at its target values (good job).

St. Lucie Estuary:

Performance Measure: Number of times salinity envelope criteria were not met for the St. Lucie Estuary.

Goal: A base flow of 350 cfs is needed to maintain appropriate salinities.

Performance: The number of months of average low flow increased from Alternative 2 to Alternative 3. A substantial amount of improvement is needed to attain the basin flow targets.

Performance Measure: Number of times high discharge criteria (mean monthly flow > 1,600 & 2,500 cfs) were exceeded for the St. Lucie Estuary.

Goal: No regulatory releases, and reduction in high discharges for > 14 days.

Performance: A Lake Okeechobee regulatory release was also seen in this alternative (there were none in Alternative 2).

Performance Measure: Minimum flow to the St. Lucie Estuary (350 cfs).

Goal: 350 cfs.

Recommendations: Continue moving toward meeting targets for low (<350 cfs) and high (>1,600cfs) flows of 50 and 13 months, respectively. The ADT needs to look at the other tributary basins (C-23, C-24, North Fork and South Fork) to make further reductions in high discharges and to contribute towards meeting minimum base flows.

Lake Worth Lagoon:

Performance Measure: Wet/Dry Season Average Flows Discharged to Lake Worth through S-40, S-41 & S-155 for the 31-year simulation.

Goal: To meet target flows to the Lake Worth Lagoon (0 - 500 cfs).

Performance: The wet and dry season both show a decrease in water to the Lake Worth Lagoon estuary. The new performance criteria in Alternative 4 will allow the subteam to see how close the model is to the targets.

Biscayne Bay:

Performance Measure: Simulated mean annual surface flows discharged into Biscayne Bay for the 1965 - 1995 simulation period.

Goal: 1995 Base condition.

Performance: Alternative 3 improves over Alternative 2 only slightly for the Miami River. All other areas show flows approximately equal, or in the case of North Bay flows, less than Alternative 2. Reduction of North Bay flows is unacceptable because of the seagrass beds and fish nursery areas in the vicinity. Alternative 3 is substantially reduced from the 1995 Base.

Recommendations: Improve estuarine conditions by increasing water flow to Biscayne Bay. At the minimum, try and reestablish the 1995 Base flow to Biscayne Bay. Additional restoration recommendations that need to be addressed include:

1. Distribution of surface flows over a wider section of shoreline, as opposed to point discharge through canals.
2. A wet and dry season allocation for Barnes Sound preferably as sheet flow through the mangrove system in the triangle is needed.
3. A higher wet season and dry season water table on the coastal ridge is needed to stimulate ground water flow.
4. Dry season allocations through all Biscayne Bay canals are needed.

Florida Bay:

Performance: P-33 stages above 6.3 ft msl correspond to a reduced frequency of undesirable high salinity events in the coastal basins of Florida Bay. There are approximately 46 months of the period of record when NSM4.5 exceeds that stage, but Alternative 3 does not, which is a large improvement over the 73 months in Alternative 2. These events occurred in the November - May dry season during 30 months over 20 years, and in the June - October wet season during 16 months over 13 years of the 31-year period of record.

Performance: P-33 stages above 7.3 ft msl correspond to an increased frequency of desirable low salinity events in the coastal basins of Florida Bay. There are approximately 18 months of the period of record when NSM4.5 exceeds that stage, but Alternative 3 does not, which is a large improvement over the 28 months in Alternative 2. These events occurred in the November - May dry season during six months over five

years, and in the June - October wet season during 12 months over eight years of the 31 year period of record.

Performance: Alternative 3 resulted in deficiencies in 6.3+ and 7.3+ foot stages at P-33 most frequently during the dry season months of January and February and the wet season months of June - August.

Recommendations: Future alternatives should concentrate on maintaining higher stages at P-33 via larger water deliveries into NE Shark River Slough in the mid-to-late dry season, particularly during January and February, and in the early-to middle wet season during June - August. Future alternatives should extend hydroperiods in the rockland marl marsh indicator region 1-3 months longer into dry seasons, based on annual rainfall patterns. Future alternatives should restore multi-year periods of flooding during extended high rainfall periods in the rockland marl marsh indicator region.

H. Big Cypress Subregion

Performance: There are some reductions from NSM water levels along the eastern side of the Big Cypress, particularly along a line from the north end of L-28 southwest to Tamiami Trail.

Rationale: L-28 could be causing the changes in water levels in the eastern portion of the Big Cypress. Given the ponding that currently exists in the lower end of WCA-3A, removal of L-28 would probably increase water levels in the adjacent Big Cypress more than would be considered desirable. However, changes scheduled to be made by 2050, suggest that this ponding will no longer exist at that time. Thus, removal or at least opening portions of the L-28 at that time could provide more natural water flows through the Big Cypress.

Recommendation: Eliminate or create openings in the L-28 to allow unimpeded exchange.

Performance: There appear to be inconsistencies with available ecological information as regards the hydroperiods in the westernmost two (three?) columns of cells in the Big Cypress that are generated by the models, particularly the NSM.

Rationale: The current and historic plant communities in this area could not exist with the indicated hydroperiods.

Recommendation: Try to determine what is causing the problem.

Performance: There appear to be large areas of northern and northeastern Big Cypress National Preserve that have major differences in hydroperiod from that predicted by the NSM. In addition to effects on the Big Cypress, could this also be affecting our ability to restore an appropriate hydrologic regime to the northwestern portion of WCA-3A.

Rationale: The causes of these differences could result from boundary problems with the model, particularly along the northwestern boundary of the Big Cypress, or effects of hydrologic alterations in the area, particularly in the northeastern corner of the area.

Recommendation: Try to determine whether there is any basis for suspecting problems with the model. Assess upstream land uses and effects of the large canals in the northeastern corner and quantify their hydrologic effects on the area to permit development of alternative components that could help to alleviate these impacts.

Note: Alternative 3 produced a very substantial improvement in matching the NSM water level regime in the western slough (Indicator Region 13).

Recommendation: The effects of removing the L-28 levee would still be interesting to see, based upon the effects observed in Indicator Regions and overland flows along the eastern portion of the preserve. Also, given system changes to be made in the 2050 Base, hydroperiods, ponding depths, and peak stages in cells adjacent to the levee do not appear to be influenced by its presence after the 1995 Base scenario. Try to determine what changes in system components and/or operations might reduce the large current differences in hydrology from that predicted by the NSM for the northeastern portion of the Big Cypress.

I. Water Quality

Performance Measure: Water Budgets / ASR.

Subteam Issues:

1. Regulatory rules for injecting were not developed envisioning recovery and re-use for environmental restoration purposes. Accordingly, water cannot generally be injected into aquifers unless the injectate meets all drinking water primary and secondary standards or an aquifer exemption is authorized by FDEP / USEPA. Additionally, there is a lengthy list of guidance concentrations for compounds, some of which are detected in surface waters in the project area, which require evaluation on a case-by-case basis. Aquifer exemption requires a substantial technical demonstration, and may be of limited duration. US EPA has never granted a major aquifer exemption.
2. Treatment facilities to meet regulatory requirements should be included in the design and cost estimates for ASR facilities (particularly for coliform bacteria, a primary drinking water standard).
3. The potential ecological impacts of using water which is treated to achieve drinking water standards for environmental restoration (e.g., low dissolved oxygen, chlorine-treated water pumped back into Lake Okeechobee) require further evaluation. Additionally, injectate recovered from an ASR well that injects into a saline aquifer may contain higher (than surface water) concentrations of chlorides and sulfates, which under certain circumstances, may enhance the production of methyl mercury and attendant bio-magnification of mercury.
4. The assumptions regarding recoverable volume may be overly optimistic. The geology of the region into which injection is proposed determines how much is recoverable (sponge vs. conduit). A thorough evaluation of subterranean geology would be necessary to predict with some certainty recoverable volumes.

Recommendations: Prior to including ASR in a recommended comprehensive plan, a more detailed evaluation of the regulatory, ecological, and geological feasibility of underground injection and recovery, including cost estimates, should be performed. An ASR issue team should probably be created to report to the AET/ADT and Restudy Team.

Performance Measure: Annual water budget for WCA-1.

Goal: Optimal hydrologic condition within Loxahatchee National Wildlife Refuge (to be determined), with water delivered achieving the phosphorous concentration requirements of the Settlement Agreement/Everglades Forever Act.

Note: Alternative 3 resulted in an increase in mean annual flows to STA-1 East of 8.7 k acre-feet (from 116.4 to 124.7) and an increase in mean annual flows to STA-1 West of 116 k acre-feet (from 163.0 to 279.0).

Recommendation: None at this time for this component (see below).

Potential Problems: Associated with rainfall-driven operations include:

1. Conveyance capacity in the West Palm Beach canal would probably have to be increased (it is assumed that Lake Okeechobee water delivered via the West Palm Beach Canal is the principal source of the increased volume).
2. STA-1 West would have to be redesigned to accommodate the increased volume; the technical feasibility of this is uncertain.
3. Alternatively, a supplementary STA would have to be designed which would be capable of treating Lake Okeechobee water (mean phosphorous concentration of 100 ppb) to meet the ultimate numeric phosphorus concentration criterion for water delivered to the Everglades Protection Area (which includes Loxahatchee National Wildlife Refuge; default concentration is 10 ppb pursuant to the Everglades Forever Act).

Recommendation: Evaluate further.

Performance Measure: Stage duration curve and daily stage hydrograph for Bird Drive Basin Reservoir.

Goal: Optimal hydrologic conditions in the east Everglades and coastal canal system.

Performance: The Water Quality subteam has concerns about the quality of seepage water and C-4 runoff water which is to be returned to ENP via L-31W (S-356 A and B pumps). The stage duration curve indicates that for 1995 Base conditions, the reservoir is dry approximately 100% of the time (elevation assumed to be approximately 7.2 ft). This simulated condition conflicts with observed conditions (elevation approximately 5.5 ft). For Alternative 3, the reservoir is dry approximately 95% of the time (combined ground water and structural inflows were 30.2 k acre-feet; combined ground water and structural outflows were 37.0 k acre-feet). In Alternative 3, the reservoir is dry more frequently than in Alternative 2.

Note: Modeling results indicate that this reservoir doesn't hold water! Additionally, observed conditions in the Bird Drive basin indicate that the basin is wetter than the model indicates for the 1995 Base condition.

Recommendations: Check topography in this region; erroneous topographic information could be affecting model outputs. Given actual hydrologic and ground elevation conditions, the ADT should give some consideration to other possible functions (e.g., wetlands). Design the reservoir to hold water longer, instead of losing it to seepage. The amount collected by the seepage collection canal is unknown (assumed to be 100% of 29.9 k acre-feet). Seepage and C-4 runoff components of water delivered to ENP via S-356 pumps must be quantified to further evaluate potential water quality impacts.

Performance Measures: Lake Okeechobee Water Quality Model (mean phosphorus in-loads and out-loads, wet year and dry year phosphorus in-loads and out-loads, median phosphorus concentrations, median chlorophyll a concentrations, mean blue-green algae concentrations, difference from future base phosphorus concentration, difference from future base chlorophyll a concentrations, difference from future base blue-green algae concentrations).

Performance: The addition of ASR did not significantly affect water quality within Lake Okeechobee. Alternative 3 was approximately equivalent to Alternative 2 and 2050 Base conditions, with one exception. Reversal of eutrophication processes is not expected to be observed during the model simulation period. One improvement was observed when comparing Alternative 3 to Alternative 2 and 2050 Base conditions, i.e. wet year (1995) phosphorous out-loads were lower than 1995 and 2050 Base conditions and the Starting Point and Alternatives 1 and 2.

Performance Measures: Everglades Water Quality Model (mean phosphorus loads to the Everglades Protection Area, combined flow-weighted phosphorus concentrations for S-12s / S-33, mean grid cell phosphorus concentrations and differences, Loxahatchee National Wildlife Refuge 14-station mean phosphorus concentration, basin phosphorus concentrations).

Goal: Water delivered to the Everglades Protection Area should not contain phosphorus concentrations exceeding the threshold at which shifts in natural populations of aquatic flora and fauna are expected to occur. These concentrations have not yet been determined (statutory default concentration = 10 ppb).

Performance: Alternative 3 Loxahatchee National Wildlife Refuge phosphorous concentrations were slightly less than Alternative 2 and 2050 Base conditions, and below long-term wet-season concentration limit specified in Settlement Agreement (see above). Alternative 3 mean structural phosphorus loads equivalent to 2050 Base, slightly increased compared to Alternative 2. Alternative 3 ground water loads significantly increased compared to the 2050 Base and Alternative 2. Alternative 3 S-12s / S-33 phosphorus concentrations slightly increased compared to the 2050 Base and Alternative 2. Alternative 3 WCA-3B mean phosphorus concentration was significantly higher than the 2050 Base and Alternative 2. All other mean basin concentrations were approximately equivalent to the 2050 Base and Alternative 2.

Recommendations: None at this time.

J. ATLSS / Threatened and Endangered / Keystone Species

The first individual-based ATLSS simulation is now available for the western sub-population of the Cape Sable seaside sparrow. For other Cape Sable seaside sparrow sub-populations, wading birds and white-tailed deer, ATLSS outputs for Alternative 3 continue to be limited to Breeding Potential Indices (BPIs). Outputs on total fish abundance and fish prey base for wading birds are also available. Differences in input data make quantitative comparisons of Alternative 2 and Alternative 3 outputs to Alternative 1 outputs and/or 1995 Base outputs impossible and makes qualitative

comparisons questionable. New performance indicators for Cape Sable seaside sparrows and American crocodiles are also addressed.

Fish:

Performance Indicator: ATLSS fish model.

Goal: None set yet.

Performance: The ATLSS fish model predicts that, due to overall wetter conditions in WCA-3B and south of Tamiami Trail, Alternative 3 hydrologic conditions will produce average fish abundances consistently higher than those expected for 2050 Base, particularly in Shark River Slough and WCA-3B. This is also true when only prey-sized fish at appropriate wading bird foraging depths are counted. Exceptions occur in East Slough and South Big Cypress, where Alternative 3 produces slightly lower fish densities than the 2050 Base. Alternative 3 results are very similar to Alternative 2, with very slightly higher fish abundance for Alternative 3.

Wading Birds:

Performance Indicator: ATLSS wading bird Breeding Potential Index.

Performance: Consistent with the fish model output, Alternative 3 would result in a slight improvement in breeding potential for wading birds over those expected for 2050 in most years due to slightly dryer conditions in the WCAs and slightly wetter conditions south of Tamiami Trail, particularly in Shark River Slough and its peripheral wetlands. Alternative 3 is very similar to Alternative 2.

Recommendation: Reduce the number of hydroperiod reversals (increase in water depth during a period of receding water depths) occurring during the December 15 to May 15 breeding period.

White-tailed Deer:

Performance Indicator: ATLSS white-tailed deer Breeding Potential Index

Performance: Alternative 3 would slightly improve the generally poor breeding conditions for white-tailed deer in SE Big Cypress, SE and East Slough regions in ENP and in wetter portions of WCA-3A, central WCA-1 and northern WCA-2A as compared to the 2050 Base, particularly in years with average to above average rainfall. Alternative 3 would slightly decrease the very low breeding potential in central Shark Slough and other portions of the WCAs. For those few areas with high deer breeding potential (Long Pine Key and surrounding short hydroperiod marsh and NW Big Cypress), there is little difference between Alternative 3 and the 2050 Base. Overall, Alternative 3 produces slightly better deer breeding potential than Alternative 2.

Recommendation: No recommendations are provided for desired improvements or structural/operational changes because no performance target has been set.

Cape Sable Seaside Sparrow:

Performance Indicator: Indicator Region 46 - Cape Sable seaside sparrow west.

Performance: On average, during the sparrow breeding season, Alternative 3 is dryer than the 2050 Base, NSM and Alternative 2. The 1995 Base produces dry conditions about three weeks earlier than Alternative 3 and re-floods the area about one week earlier than Alternative 3.

Performance Indicator: ATLSS Cape Sable seaside sparrow Breeding Potential Index.

Performance: For the western sparrow sub-population, Alternative 3 produced improved breeding potential in the northern portions of this habitat, and slightly lower breeding potential in the southern portions as compared to the 2050 Base, with a net improvement for this sub-population over 2050 Base and Alternative 2. For the core sparrow sub-population, breeding potential is very slightly lower for Alternative 3 as compared to the 2050 Base, and Alternative 3 breeding potential is essentially indistinguishable from Alternative 2. For the eastern sub-populations, Alternative 3 produces lower breeding potential than the 2050 Base and slightly lower breeding potential than Alternative 2. However, the Breeding Potential Index model does not consider possible beneficial effects to eastern habitat areas due to reduced shrub cover and reduced fire frequency.

Recommendations: Any actions that would further decrease late wet season and dry season flows west of Shark River Slough, particularly in wet years, would further improve breeding potential for the western sparrow sub-population. For the core and eastern sub-populations, slightly reduced dry season flows, consistent with NSM, would increase breeding potential while preserving expected beneficial effects to sparrow habitat due to improved NE Shark Slough hydroperiods.

Performance Indicator: ATLSS Cape Sable seaside sparrow Individual-based Simulation.

Performance: The ATLSS individual-based sparrow simulation is applied only to the western sub-population, and predicts persistence of this sub-population under Alternative 3, with numbers dropping below 1,500 individuals three times. Under the 2050 Base, this model consistently predicts extirpation of the western sub-population.

Recommendations: The WCA-3 decompartmentalization scenario produces even drier conditions than Alternative 3 in the western sparrow area. Therefore, full or partial implementation of this scenario will likely further improve conditions for the western sparrow subpopulation. Any other means of further reducing dry season flows, especially in wet years, would likely benefit the western sparrow sub-population.

American Crocodile:

Performance Measure: Proposed measure is being programmed.

Performance: In absence of performance measure outputs, inspection of available Florida Bay salinity outputs indicates reduced salinities under Alternative 3 that would correspond to increased crocodile habitat suitability as compared to the 2050 Base, 1995 Base, Starting Point and Alternatives 1-2.

Recommendations: Increased flows to Florida Bay, particularly in dry years, would provide further improvements in crocodile habitat suitability.

AET Subteam Narratives

A. Total System Subregion

Performance Based Comments:

The 1989 Dry Year Hydroperiod Distribution Map for the NSM shows five surviving 365-day-long hydroperiod areas linked by intermediate-to-long hydroperiod class wetlands that may have served as a dry-year refugia for fish and other aquatic species, allowing them to repopulate the system more efficiently when wet conditions returned. Looking at the hydroperiod distribution performance measure, Alternative 3 shows an NSM-like number of acres of long-hydroperiod wetlands. Looking at the maps, however, they are (not surprisingly) not located where they were according to the NSM. The exact location may not be as critical as their being evenly distributed across the landscape and linked for over 300 days even in a typical dry year.

Performance Measures and Indicators Used: Hydroperiod Distribution: 1989 maps for NSM, 2050 Base, and Alternative 3, and the histogram.

Improvement over 2050 Base:

Alternative 3 increases the system-wide area of long-hydroperiod wetlands over the 2050 Base to near NSM values, particularly in northern Shark River Slough, the northwest corner of WCA-3A and northern Loxahatchee NWR. Four of the five original dry-year refugia are more or less there in Alternative 3.

Recommendations:

In general, the groups of long-hydroperiod cells could be more focused, better located and better connected to each other. The ponding of water in WCA-3B is preventing enough water from reaching the important central part of Northeast Shark River Slough. Barriers themselves and the pooling they cause at the southern end of Loxahatchee NWR and WCA-2A allow areas downstream of them to dry out. This disconnects the dry year pools from each other hydrologically, which would reduce the ability of fish to repopulate the system after a severe drydown. More water still needs to be sent to the northwestern corner of WCA-3A to restore that core area where it once was located and to allow water to flow directly south to connect this area with the surviving one in western WCA-3A. Increasing the hydroperiods in northwestern WCA-3A area may improve the drier than NSM conditions occurring in Mullet Slough.

Performance Based Comments:

Alternative 3 improves hydroperiods in a greater area than any previous plan but in many areas, the area that either exceeds NSM hydroperiods (or in some cases falls short) is still large.

Performance Measures and Indicators Used: Hydroperiod Improvement.

Improvement over 2050 Base:

Alternative 3 is the best plan yet for improving hydroperiods. Alternative 2 improved 358,000 acres, Alternative 3 improved 422,000 acres. The areas exhibiting extreme hydroperiods (either too long or too short) are for the most part in the less severe 7 to 30 day category.

Recommendations:

Continue to minimize the amount of area with too short or too long hydroperiods. In some areas (Loxahatchee, WCA-3B, and Rotenberger) the number of acres improved is actually smaller than the area that exceeds NSM under Alternative 3. WCA-2A, WCA-2B and Holey Land also have a fairly large proportion of worsened hydroperiods compared to area improved. Throughout most of the system excessive hydroperiods were the problem but in Rotenberger, Holey Land, and Pennsuco, significant areas exhibited shortened hydroperiods as well. Increased conveyance into northwest WCA-3A from Rotenberger and Holey Land may help both WCA-3A and these state-owned natural areas. Everglades National Park looks good overall but the sloughs could still use longer hydroperiods. Unless it is decided to select some of the unnaturally pooled areas to serve as substitute dry season refugia, hydroperiods need to be reduced in the places where water is pooling, usually upstream of canals and levees. It would be best to reconnect the areas divided by barriers in a way to make them useable by fish and other aquatic species as well as to restore hydrologic conveyance.

Performance Based Comments:

The percent of Hydroperiod Matches throughout the system has increased with Alternative 3 with the largest benefits going to Loxahatchee NWR (from 79% to 95%), Pennsuco (from 25% to 50%), and WCA-2B (from 55% to 82%).

Performance Measures and Indicators Used: Percent of Hydroperiod Matches with NSM.

Improvements over 2050 Base:

Of the over 1.4 million acres of the remaining Everglades, 80% match NSM in Alternative 3. This is 12% better than the 2050 Base with substantial improvements in WCA-2B (+27%), WCA-3B (+22%), Everglades National Park (22%), Pennsuco (25%), and Loxahatchee NWR (18%).

Recommendations:

Continue to improve hydroperiods throughout the system, particularly in WCA-3B, Rotenberger, Holey Land and Pennsuco, which still show a low percentage of hydroperiod matches with NSM.

Performance Based Comments:

The southern end of Loxahatchee and WCA-2A are one depth class too deep (0.5 to 1.0 ft higher than NSM) caused by water pooling above the canals and levees. Eastern WCA-3A and the area around L-67 are also too deep. WCA-2B is two classes too deep (one to more than two feet higher).

Performance Measures and Indicators Used: Percent of cells matching NSM ponding depths.

Improvements over 2050 Base:

For the remaining Everglades, over 83% of the area now matches NSM ponding depths, 8% more than the 2050 Base and 21% more than the 1995 Base. Everglades

National Park, which represents 486,000 acres of the 1.4 million acres, is now at 100% in Alternative 3.

Recommendations:

Lower the water elevations in WCA-2B. Even if a long hydroperiod could make it a suitable dry year refuge, depths are excessive. Improve conveyance through L-67 so that the deeper water area ends up south of Tamiami Trail in the sloughs where it belongs.

Comments from the Web Site:

Comments from Thomas Corcoran, representing National Audubon Society and Dr. Mark Kraus, Dr. Wayne Hoffman, Jerry Lorenz, Karsten Rist:

1. Hydroperiod Distribution: “The northern part of Taylor Slough shows hydroperiod improvements in Alternative 3 versus Alternative 2 on the Hydroperiod Differences Maps.”
2. “Hydroperiod Differences Maps Mean and Dry Years: refer to Hydroperiod Differences Annual Average and Dry 1989 Hydroperiod Differences Maps for Alternative 3. Maps show inundation of WCA-3A and 3B to be fairly evenly distributed. What influence do the canals/structures have on sheetflow in these areas? Will there be ponding on the northern side of the levees? Will the canals expedite movement of water in the canal flow direction. Is this what we are seeing on these maps, i.e. a drying out on the northern part of the Miami Canal in WCA-3A and increased ponding on the southern end of the Miami Canal in WCA-3B?”
3. “Hydroperiod Differences Maps 1989 Dry, Alternative 3, L-29 Canal, S-12 structures: Based on this Map, why does the rainfall driven delivery schedule cause a ponding above the S-12 structures north of L-29 and some drying out south of the S-12 structures south of L-29?”

Comments from Tom MacVicar, representing the Agriculture Coalition commented on the Stage Hydrographs at EAA Reservoir:

1. “This reservoir continues to produce a significant net reduction of water to the Everglades system in most years. The 40,000 acre tract that receives only regulatory flow from the Lake cannot be justified based on the infrequent use it shows in Alt 3.”

He also offered following comment on the Caloosahatchee Reservoir:

2. “The water budget for the Caloosahatchee reservoir seems to show the extraction of water that has been stored underground as much as 5 years after it was pumped down. This does not seem reasonable and should not be assumed to be possible unless there is strong documentation that it can be done.”

B. Kissimmee / Lake Okeechobee Subregion

Performance-Based Comments:

There were no performance measures evaluated for the Kissimmee region.

Water inputs to the lake were increased by approximately 1% under Alternative 3 as compared to the other alternatives and base conditions. Water losses from the lake changed by less than 1%. There were some notable changes in regional inflows and outflows, including 145,000 acre-feet of new outflows to ASR wells, and 67,000 acre-feet of return flow from those wells. Under Alternative 3 there also was approximately a doubling of water flow from the lake to the Everglades. Consideration needs to be given to the fact that this will necessitate additional downstream treatment systems, since water exiting the lake contains 70 to 80 µg/L of total phosphorus.

The stage duration curve for Alternative 3 is markedly flatter than the duration curves of other alternatives and the base runs. In other words, the percent occurrence of high and low lake stage events is reduced. This is a positive result.

Box-and-whisker plots showing the “similarity in lake stages” indicate that 25th and 75th percentiles for water levels under Alternative 3 were within a 12 to 15 ft NGVD depth range. This degree of fluctuation is considered desirable for protecting the lake’s ecological values. Extreme lows and highs still occurred under Alternative 3, but at a relatively low frequency (see below).

The daily stage hydrographs indicate the following return frequencies (number of events in 31 years) for extreme high (>17 ft NGVD) and low (<11 ft NGVD) lake stages:

Category	Goal	95 Base	50 Base	Alt 2	Alt 3
>17 ft	Few Events	6	5	4	3
<11 ft	Few Events	8	12	9	6

The changes under Alternative 3 represent positive results from the standpoint of protecting the lake ecosystem. When lake levels reach 17 ft NGVD, wind-driven waves can seriously damage native plant communities and fisheries habitat, even in very short time periods, and there also may be considerable nutrient transport into the oligotrophic marsh from the eutrophic pelagic zone. When lake levels fall below 11 ft NGVD, nearly all of the littoral marsh is exposed to drying, it no longer can serve as a habitat for fish and other aquatic animals, and it is at increased risk for expansion of exotic plants.

Box-and-whisker plots showing the similarity in duration of stage events >15 ft NGVD indicate that under Alternative 3, both the median and 75th percentile durations for such events were reduced to below six months. This also is a positive result.

Prolonged periods of moderately high lake levels (which are rare under this alternative) harm the ecosystem due to losses of benthic plant communities, and greater lake-wide circulation of turbid, phosphorus-rich water. Increases in lake-wide phosphorus concentrations could impact downstream ecosystems that receive water from the lake.

Box-and-whisker plots showing the similarity in duration of stage events <12 ft NGVD indicate that under Alternative 3, both the median and 75th percentile durations for such events were reduced to below six months. This is another positive result. Prolonged periods of moderately low lake levels harm the ecosystem due to losses of wildlife habitat and increased rates of exotic plant expansion.

Box-and-whisker plots showing the similarity in duration of stage events <11 ft NGVD indicate that under Alternative 3 there continued to be a relatively long median duration for such events, and an extreme value of >400 days. Such events are harmful to the ecosystem, but as noted above, their frequency of occurrence was relatively low (six events in 31 years).

None of the scenarios evaluated to date, including Alternative 3, had significant effects on the frequency of occurrence for spring lake level recessions. In all cases, January to May recessions from 15 to 12 ft NGVD (without major reversals) occurred in approximately 20% of years. In light of the other positive results, and continued uncertainties regarding linkages between recession characteristics and ecological values, there are no strong recommendations to address the issue at this time.

Performance Measures and Indicators Used:

Measures: box-whisker plots showing similarity in lake stages
 box-whisker plots showing duration of >15 ft lake stage events
 box-whisker plots showing duration of <12 ft lake stage events
 box-whisker plots showing duration of <11 ft lake stage events
 daily hydrographs with spring recession windows

Indicators: lake inflow, outflow, and ET volumes
 30 year daily hydrographs
 stage-duration curves

Recommendations:

Performance measure: Number of stage events >17 ft NGVD.

Goal: Low frequency of occurrence.

Summary: Alternative 3 reduced the number of events to three; this compares favorably with Alternative 2 (four events), the 2050 Base (five events) and the 1995 Base (six events).

Recommendation: Maintain the features that led to this positive result.

Performance measure: Number of stage events >15 ft NGVD lasting > 6 months.

Goal: Low frequency of occurrence.

Summary: Alternative 3 reduced the number of events to three; this compares favorably with Alternative 2 (six events), the 2050 Base (six events), and the 1995 Base (seven events). Alternative 3 also had a median duration that was well below six months.
Recommendation: Maintain the features that led to this positive result.

Performance measure: Number of stage events <12 ft NGVD lasting >6 months.

Goal: Low frequency of occurrence.

Summary: Alternative 3 reduced the number of events to five; this compares favorably with Alternative 2 (seven events) and the 2050 Base (eight events), but exceeds the 1995 Base (three events). The median duration of events under Alternative 3 was well below six months, and lower than under all other scenarios.

Recommendation: No specific recommendations; generally a positive result.

Performance measure: Number of stage events <11 ft NGVD.

Goal: Low frequency of occurrence.

Summary: Alternative 3 reduced the number of events to six; this compares favorably with Alternative 2 (nine events), the 2050 Base (12 events), and the 1995 Base (eight events).

Recommendation: Maintain the features that led to this positive result.

Comments Received By Email from Outside Reviewers:

1. Tom MacVicar (Representing the Agriculture Coalition)

“The model indicates improvement in the low lake stages due to the addition of ASR water. The technical basis for application of ASR on this scale does not exist. Any conclusions regarding the performance of Alt 3 must include an appropriate disclaimer indicating the lack of evidence the ASR as proposed in Alt 3 will work.”

2. Thomas Corcoran (National Audubon Society)

“Alt 3 shows improvement compared to Alt 2 on the stage duration curves in respect to lake stages exceeding 15 ft NGVD (represents the lake elevation above which the entire littoral zone is flooded).”

“Alt 3 shows improvement compared to Alt 2 on the stage duration curves in respect to lake stages falling below 12 ft NGVD (...more than 90% of the littoral zone is dry).”

“Looking at the number of undesirable Lake Okeechobee stage events it appears that Alt 3 had increased the number of times stages are greater than 17 ft for greater than 50 days. However, the number of times stage events are greater than 15 ft for greater than 2 years has been eliminated.”

C. Lake Okeechobee Service Area Subregion

Performance Based Comments:

The state's water supply planning goal of meeting demands in a 1-in-10 year drought, which has been incorporated as a Restudy performance goal, is not met by Alternative 3. Examination of the "Frequency of Water Restrictions" performance measure shows that the Lake Okeechobee Service Area is modeled as being under supply-side management (not all demands being met) for eight events. A maximum of three events would be allowed in order to achieve the goal of meeting demands in a 1-in-10 year drought. In addition, two of the events last nine months, which is longer than the target maximum duration of seven months. In 1981 and 1982 there is a continuous period of 15 months in which not all demands were met.

Water supply conditions in Alternative 3 are modeled as being better than those of the base years. Years with water restrictions were ten in the 1995 Base and increased to 15 in the 2050 Base. Water supply conditions in Alternative 3 were also modeled as being better than those in the previous alternatives. Years with water restrictions were 11 in Alternative 1 and 12 in Alternative 2.

Along with the reduction in the number of events in which demands were not met has come a reduction in the amount of demands not met. In Alternative 3 the percentage of demands not met was 10% in the EAA and 12% for the rest of the Lake Okeechobee Service Area. This is less than the percentage not met for the 1995 Base (11% and 15% respectively), for the 2050 Base (22% and 23% respectively) and for Alternative 2 (15% and 15% respectively). The basin which had the lowest percent of demands not met was the Caloosahatchee Basin (5.6% in Alternative 3). This apparently resulted because water was often available in the reservoir for a time after the lake entered supply-side management

Maintaining existing levels of flood protection is also a goal in the Lake Okeechobee Service Area. Available performance measures that indicate whether flood protection is being maintained include peak stage difference maps and statistics on backpumping from the EAA to Lake Okeechobee contained in the EAA water budget. These measures only apply to the EAA. Both these sources indicate that flood protection has not deteriorated. Higher peak stages are not observed in the EAA outside of reservoirs, STAs and environmentally managed areas. In addition backpumping to Lake Okeechobee, which occurs only when flood waters reach threatening levels, is less in Alternative 3 than it was in the 1995 Base. A more discerning flood control performance measure is still being developed and was not available for the evaluation of Alternative 3.

Performance Measures and Indicators Used:

1. Frequency of Water Restrictions
2. Lake Okeechobee Daily Stage Hydrograph
3. Mean Annual EAA/LOSA Irrigation Demands and Demands not Met
4. Report – Monthly and Annual Supply-Side Management Results
5. Report – Cumulative Total Demand, Cutback Volume, and Cutback over Period of Simulation
6. Water Shortages by Phase and Trigger output

7. EAA and LOSA Demands – Dry Years
8. Total Irrigation Supply and Shortages for Seminole Tribe, Big Cypress Reservation
9. Lake Okeechobee Service Area Subregion Reports on Annual Demands & Demands not Met
10. C-43 & C-44 Basin Regional Irrigation Supply and Demand not Met
11. Other LOSA Supplemental Irrigation Supply and Demand not Met
12. Number of Undesirable Lake Okeechobee Stage Events
13. Peak Stage Differences (.25 ft. higher)
14. Average Inflows and Outflows to Lake Okeechobee

Public Comments Received (paraphrased):

1. Gail Murray for the Seminole Tribe: Improvement from Alternative 2 was noted. Continued progress toward meeting 1-in-10 goal was requested.
2. Steve Lamb for the Agricultural Coalition: Water restrictions were stated as being unacceptable. Concerns were expressed about the feasibility of the ASR systems as modeled, especially regarding capability of storing the quantities modeled, the capability of recovering 70% and the quality of water that would be recovered.

D. Lower East Coast Subregion

Summary: Alternative 3 improves the ability of the regional system to meet water supply demands for the Lower East Coast when compared to Alternative 2 but only slightly. Alternative 3 fails to meet the 1 in 10 year water demand. Shortages triggered by local ground water levels and Lake Okeechobee levels are too frequent. The majority of the local ground water trigger cutbacks in the service areas are due to just a few wellfields, i.e. low groundwater levels are not affecting the entire service areas. Addressing these few wellfields will enable the service areas to avoid cutbacks. The shortages due to Lake Okeechobee levels still need to be addressed. The number of cutbacks has not declined over the 1995 Base. In addition, saltwater intrusion continues to be a threat in southern Service Area 2 and most of Service Area 3. Flood protection in the south Dade area continues to be a problem.

Water Supply

Performance Based Comments:

Locally triggered events were reduced to zero. The frequency of Lake Okeechobee shortage events are still too high. There were five Lake triggered cutbacks for the service area.

Performance Measures and Indicators:

1. Frequency and Severity of Water Restriction Triggers for the 1965-1995 Simulation Period for North Palm Beach Service Area.
2. Frequency of Water Restrictions for the 1965-1995 Simulation Period – North Palm Beach County.

Recommendation:

The number of locally triggered events has been reduced to zero. Moving the Riviera wellfields has helped. More water needs to be available from Lake Okeechobee or perhaps change how events are triggered.

Subteam Issues: Please identify where the new demands for Riviera are located.

Performance Based Comments:

Only one locally triggered shortage event occurred during the period of record. The frequency of shortage events caused by Lake Okeechobee is too high. There were five Lake triggered cutbacks for the service area. The Water Catchment Area is not performing as well as it could. It dries out more frequently than the Loxahatchee Slough.

Performance Measures and Indicators:

1. Frequency and Severity of Water Restriction Triggers for the 1965-1995 Simulation Period for Service Area 1.
2. Frequency of Water Restrictions for the 1965-1995 Simulation Period – Service Area 1.

Recommendation:

More water needs to be available from Lake Okeechobee. Also, adding ASR to Component K2 may improve the performance of the Water Catchment Area.

Performance Based Comments:

Twelve shortage events for the period of record are caused by locally trigger wells. The frequency of events caused by Lake Okeechobee are also too high. There were five Lake triggered cutbacks for the service area. The well triggers located at Pompano, Hollywood, Ft Lauderdale Airport, and North Lauderdale are causing the cutbacks. Hollywood and Ft. Lauderdale Airport are the most problematic. Moving Hollywood's demands west has helped. The number of months has been reduced from 40 in Alternative 2 to 25 in Alternative 3, but moving the water supply demand has not solved the problem. The number of cutbacks at the remaining wells were not reduced in from the number in Alternative 2.

Performance Measures and Indicators:

1. Frequency and Severity of Water Restriction Triggers for the 1965-1995 Simulation Period for Service Area 2.
2. Frequency of Water Restrictions for the 1965-1995 Simulation Period – Service Area 2.

Recommendation:

More water needs to be available from Lake Okeechobee. Either seepage could be added to send ground water south and east to recharge wellfields and the C-9 and North New River canals or move it south to ENP. The Pompano trigger well experiences five locally triggered cutbacks. Pompano also currently experiences saltwater intrusion problems in their wellfields. The easternmost pumpages should be moved to the North County Regional Wellfield in Alternative 4.

Performance Based Comments:

Seven shortage events for the period of record are caused by local trigger wells. The wells causing problems in Service Area 3 are Homestead (14 times), Florida City (one time), Cutler Ridge (two times), N Miami (one time), Miami (two times, and Taylor (five times). The number of wells affected has increased from three in Alternative 2 to six wells in Alternative 3. In addition, there are five Lake Okeechobee triggered events for Service Area 3.

Performance Measures and Indicators:

1. Frequency and Severity of Water Restriction Triggers for the 1965-1995 Simulation Period for Service Area 3.
2. Frequency of Water Restrictions for the 1965-1995 Simulation Period – Service Area 3.

Recommendation:

More water needs to be available from Lake Okeechobee. Perhaps, mounding water or increasing ground water seepage for Miami-Dade County would reduce the number of locally triggered cutbacks.

Canal Levels

Performance Based Comments:

All canal levels meet or exceed the salt-water intrusion criteria for the North Palm Beach Service Area.

Performance Measures and Indicators:

1. % of time Canal Stage less than Saltwater intrusion Criteria and Occurrences greater than one Week for North Palm Beach Service Area.
2. Stage hydrographs.
3. Stage duration curves.

Performance Based Comments:

All canal levels meet or exceed the salt-water intrusion criteria for Service Area 1.

Performance Measures and Indicators:

1. % of time Canal Stage less than Salt-water intrusion Criteria and Occurrences greater than one Week for Service Area 1.
2. Stage hydrographs.

3. Stage duration curves.

Performance Based Comments:

The C-9 and C-14 Canals fail to meet the saltwater intrusion criteria. The C-14 experiences limited drops in water levels (2% of the time). The C-9 drops below the saltwater intrusion criteria 5% of the time, which is better than Alternative 2, yet exceeds the goal of no water levels below the saltwater intrusion criteria.

Performance Measures and Indicators:

1. % of time Canal Stage less than Salt-water intrusion Criteria and Occurrences greater than one Week for Service Area 2.
2. Stage hydrographs.
3. Stage duration curves.

Recommendation:

The stage duration curves show that approximately half of the time, water levels for all alternatives are at a height which is at or just above the salt intrusion trigger level. Both the 1995 Base and 2050 Base have water levels that more than half of the time are at least a few inches higher than the salt intrusion triggers. The difference of a few inches in hydraulic head may be sufficient to provide more freshwater deliveries to the bay via groundwater and the aquifer near the Hollywood wellfields. Alternatives that support higher water levels to prevent salt intrusion and trigger shortages are necessary.

Performance Based Comments:

Flows over S-13 and S-13A are reduced by half and to zero, respectively, diminishing the amount of water supplied to the Pond Apple Slough. The Slough is located just east of the Ft Lauderdale Airport. Rehydration of the Slough, a joint project by the SFWMD and Broward County – DNRP, requires additional waters to be sent east on the C-11.

Performance Indicators:

1. Mean wet/dry Season Flows to Pond Apple Slough through C-11@S-13 for the 31 year simulation.
2. Stage hydrographs.
3. Stage duration curves.

Recommendation:

Modify operation of C-11 and C-9 Reservoirs to provide more flows east. Operation of the structures may need to be modified as well.

Performance Based Comments:

Flows over S-33 remain constant on all runs. It has been documented by DNRP that additional flows are necessary to prevent saltwater intrusion. Restoration of the North Fork of the New River is a Critical Project of the Corps and is sponsored by Broward County.

Performance Indicators:

1. Mean wet/dry Season Flows to North Fork of New River C-12@S-33 for the 31 year simulation.
2. Stage hydrographs.
3. Stage duration curves.
- 4.

Recommendation:

Provide more flows east on the C-12.

Performance Based Comments:

Alternative 3 shows a decrease in the number of saltwater intrusion trigger events relative to Alternative 2 for the C-6. The canal is below the criterion only 4% of the time. Alternative 3 shows a significant increase in the number of saltwater intrusion trigger events relative to Alternative 2 for the C-4. The canal is below the criterion 27% of the time. Alternative 3 shows a significant increase in the number of saltwater intrusion trigger events relative to Alternative 2 for the C-2. The canal is below the criterion 21% of the time.

Performance Measures and Indicators:

1. % of Time Canal Stage < Salt-Water Intrusion Criteria and Occurrences >1 Week - Canal C-6 at S-26, C-4 @S-25B, and [C-2@S-22](#).
2. Stage duration curves.
3. Stage hydrographs.

Recommendation:

Provide additional flows to C-4 and C-2 and fix the constraints in the local and regional system.

Performance Based Comments:

Many of the South Dade County Canals water levels have declined or shown no improvement in Alternative 3. C -100A, C-103, and C-1 have declined in water level with respect to the 95 Base. C-100B, C-102N, and C-102 have shown no improvement with respect to 1995 Base. The lack of water supply to these canals is resulting in the triggering of water shortages in South Dade. Additional water should be put into these canals to reduce water shortages in South Dade.

Performance Indicators:

1. Stage duration curves for C-100A, C-100B, C-102N, C-103, C-111, C-103S, C-102, and C-1.
2. Stage duration curves.
3. Stage hydrographs.

Reservoirs

Subteam Issues: STAs for components Y3 and X3 in C-51 and C-17 Basins may be placed on sensitive wetlands. The ADT may want to reconsider placement.

Performance Based Comments:

Even with addition of ASR, less water is available from the Site 1 reservoir in Alternative 3 than in Alternative 2. The reservoir is dry 30% of the time and the duration curve is much lower in Alternative 3 than in Alternative 2.

Performance Indicator:

1. Stage duration curves for Site 1 Reservoir.

Subteam Issues: How cost effective is reservoir and ASR? Could ASR replace above ground reservoir. Also how risky is it to rely so heavily on ASR?

Performance Based Comments:

C-11 Reservoir performs the same as in Alternative 2. Too much water is going south and west. The ADT needs to send more water east to supply wellfields.

Performance Indicator:

1. Stage duration curves for C-11 Reservoir.

Recommendation:

Send more water east to Pond Apple Slough.

Performance Based Comments:

The C-9 reservoir is dryer 20% of time in Alternative 3 when compared to Alternative 2. May be too much water going South and West.

Performance indicator:

1. Stage duration curves for C-9 Reservoir.

Recommendation:

Send more water east to wellfields and keep C-9 above saltwater intrusion criterion at eastern structure.

Performance Based Comments:

The Bird Drive Basin Impoundment appears incapable of preventing saltwater intrusion in C-2 and C-4 canals. Operation of this impoundment needs to be reexamined and/or more water needs to be routed from the regional system to hold consistently higher levels in these canals. The stage duration curve exceeds ground elevation only 5% of the time.

Performance Indicator:

1. Stage duration curves for Bird Drive Reservoir.

Recommendation:

The ADT may need to address water quality concerns. This facility is located within the West Wellfield Interim Protection Area and, therefore, only water of the appropriate quality should be back pumped into this facility.

Performance Based Comments:

The Central Lakebelt Storage described in Alternative 3, Component Map 6 has only 100,000 acre feet of storage of which perhaps half or 50,000 acre feet is available because of evaporation. This could potentially supply 44 mgd to meet all demands. It is apparent that there are too many demands on this reservoir and its storage is inadequate, particularly in view of the increase in the potential for saltwater intrusion in Alternative 3 for C-2 and C-4. It is also unclear as to how other lakes within the Lake Belt will function within this overall plan in providing additional storage. It is very clear from Alternative 3, however, that additional storage or water supply from the regional system is needed.

Performance Indicator:

1. Stage duration curves for Central Lakebelt Reservoir.

Recommendation:

Enlargement of this reservoir to north of the C-6 Canal appears necessary to provide enough effective storage.

Subteam Issues: In Alternative 4 a performance indicator for the Northwest Wellfield and the cell to the east of the Northwest Wellfield located at R25C29 and R25C30, respectively, showing stage hydrographs and monthly percent duration curves for each alternative should be included. Likewise this should also be run for the West Wellfield at R21C27 (this location should be checked), and for the Bird Drive Basin Impoundment. A new Miami-Dade County wellfield has been included in these Alternative runs in the southwest, and the location of this wellfield needs to be identified with performance indicators run for it as recommended above.

Discharges to Tide

Performance Based Comments:

For Alternative 3, there is a trend from north to south of decreasing discharges to tide while failure to meet saltwater increases. Discharge to tide in the North Palm Beach Service Area remain constant when compared to the 1995 Base and saltwater intrusion criteria for major canals is met. For Service Area 1, there is a 45% average annual decrease (361k acre-feet/yr) in discharges to tide when compared to the 1995 Base and the saltwater intrusion criteria for major canals is met. For Service Area 2, discharges to tide decrease approximately by 29% (137 k acre-feet/yr) on average compared to the 1995 Base, while two canals, the C-9 and C-14, were unable to meet their saltwater intrusion criteria. In the case of Service Area 3, there is a 42% decrease in discharges to tide on average (410 k acre-feet/yr) when compared to the 1995 Base, while all of the primary canals fail to meet their saltwater intrusion criteria and many of the smaller canals are dry for a portion of the year. The total reduction in discharges to tide on average is 928,000 k ac/ft ~1 million acre feet.

Performance Indicator:

1. Mean Annual Surface Flows Discharged to Tide from the LECSA for the simulation period.

Water Deliveries

Performance Based Comments:

The number of days water deliveries were made to LECSA from the regional system increased by 10% to 50% for all of the service areas in Alternative 3 when compared to the 1995 Base. But the volume of water supplied on average has declined when compared to the 1995 Base for Service Area 1 by 50%, increases for Service Area 2 by 200%, and increases for Service Area 1 slightly. Is the Central Lake Belt reservoir able to provide the 60+k ac/ft no longer provided by the regional system? This reservoir may not be performing as well as it could since canal levels are low and there are many local ground water trigger events. During drought events, deliveries have declined for Alternative 3 when compared to Alternative 2. However the LECSAs are more dependent on the regional system in Alternative 3 than in the 1995 Base. During wet years, the service areas have gained some self-sufficiency, but they are still dependent on the regional system during drought events. The decline in deliveries can also be seen in the decline in flows to Biscayne Bay.

Performance Indicator:

1. Number of days and volume LECSA Water Supply Deliveries were made from Lake Okeechobee for simulation period.

Recommendations:

Increase deliveries to Service Area 2 and 3 as needed (or increase ground water seepage).

Flood Protection

Performance Based Comments:

The stage hydrographs indicate an increase in flooding potential when comparing Alternative 3 to the 1995 Base, and 2050 Base. The 2 foot root zone is exceeded 21 to 62 times for these cells.

Performance Indicator:

1. Stage Hydrographs for R10C25, R17C27, and R15C26.

Recommendations:

Capture wet season seepage from L-31N moving east into the agricultural areas.

Performance Based Comments:

The stage hydrograph indicates no change in the flooding potential when comparing Alternative 3 to the 1995 Base. However, the 2 foot root zone is exceeded excessively.

Performance Indicator:

1. Stage Hydrograph for R19C27.

E. Northern / Central Everglades (WCAs, Holey Land, Rotenberger)

Loxahatchee National Wildlife Refuge (WCA-1)

Performance Based Comments:

Overall, Alternative 3 does a good job of mimicking NSM hydroperiods within WCA-1 with 95 % of the area matching the NSM target. This reflects a 17% improvement over the 2050 Base case, and a 16 % improvement over Alternative 2. Progress was made in Alternative 3 towards reducing water depths in the southern portion of WCA-1, an area currently impacted by prolonged high water periods. Water depths remain higher than NSM conditions however, Alternative 3 exceeded the high water criterion (2.5 ft) fewer times (17 events with an average duration of five weeks) than Alternative 2 (30 events/12 weeks average duration). Alternative 3 met the NSM target in north/central WCA-1 with zero number of times in which water levels exceeded 2.5 ft thus protecting existing tree island communities. In terms of the number of times the area dried out over the 31-year period of record, Alternative 3 performed about the same as the 2050 Base case.

Performance Measures and Indicators Used:

1. Hydroperiod difference map.
2. Indicator Region statistics for Regions 26 and 27 (inundation duration summary table, high water/low water summary table, stage duration curves, temporal variation in weekly stages).

Recommendations:

Decrease ponding in southern WCA-1 to better match NSM conditions.

Subteam Issues:

Issues relating to water supply trade-offs between areas, water quality, and appropriate targets for LNWR need to be discussed considering the water cost for maintaining rainfall-driven, NSM-like hydroperiods is roughly 100,000 acre feet per year from Lake Okeechobee. If NSM conditions are desired, the ADT should continue to utilize the rainfall-driven water deliveries to WCA-1 as part of the regional restoration strategy for the Everglades.

WCA-2A

Performance Based Comments:

Alternative 3 shows improvement over Alternative 2 with respect to matching NSM hydroperiods as it approaches the NSM target (89% for Alternative 2, 92% for Alternative 3, and 94% for NSM).

Under Alternative 3, peak water depths exceed 2.5 ft in southern WCA-2A during several of the wettest years compared to zero exceedences for NSM. This is similar to water depth patterns simulated in the 2050 Base case and Alternative 2 but greater than the 1995 Base case.

In northern WCA-2A (Indicator Region 25) there are fewer occurrences of low water (-1.0 ft below ground) than in NSM or Alternative 2 (seven low water events for Alternative 3 vs. 11 for NSM and Alternative 2). However, to the south (region 24), water depths are less than 1.0 ft below ground on ten occasions for Alternative 3 as compared to five times for the NSM. This does not show improvement over Alternative 2 or 2050 Base, but is better than the 1995 Base (12 events).

In northern WCA-2A, water depths increase earlier in the wet season and recede faster in the dry season as compared to NSM. In the south, mean wet season high water is approximately 0.5 ft higher than NSM, but mean dry season low water matches NSM. This pattern is similar to the 2050 Base but is somewhat deeper than 1995 Base. Year-to-year standard deviation is improved over 2050 Base and Alternative 2, but still exceeds NSM.

Performance Measures Used:

1. Inundation Duration. Mean hydroperiod, number of inundation events, and mean duration of inundation were compared for match with NSM values.
2. Extreme High Water (protection of tree islands). The frequency and duration of events in which depths exceeded 2.5 ft were calculated, with a planning target of zero exceedences of the criterion.
3. Extreme High Water (NSM flood levels). The frequency and duration of high-water periods in which depths exceeded NSM values were calculated, with a planning target of zero exceedences of NSM values.
4. Extreme Low Water (protection of peat soils). The frequency and duration of events in which depths fell below -1.0 ft were calculated, with a planning target of zero exceedences of the criterion.
5. Extreme Low Water (NSM low water levels). The frequency and duration of low-water periods in which depths fell below NSM minima were calculated, with a planning target of zero exceedences of NSM values.

Performance Indicators Used:

1. Normalized Weekly Stage Hydrograph for Indicator Regions 24 and 25
2. Temporal Variation in Mean Weekly Stage for Indicator Regions 24 and 25
3. Inundation Pattern (1965-1995) for Indicator Regions 24 and 25
4. Stage Duration Curves for Indicator Regions 24 and 25
5. Stage Duration Curve at Gage 2-17

Recommendations:

Adjust water level triggers within WCA-2A in an effort to lower water levels slightly during above normal rainfall years to protect remaining tree island communities. Reduce frequency of extreme low water events.

WCA-2B

Performance based comments:

Due to a modeling glitch this region was not evaluated for this Alternative. A full evaluation will be conducted during the next cycle.

Holey Land and Rotenberger WMAs

Performance Based Comments:

For both the Rotenberger and Holey Land WMAs, Alternative 3 did a better job than Alternative 2 and the 2050 Base in mimicking NSM hydroperiods and water levels as measured by time series stage hydrographs, stage duration curves and weekly temporal variation in water levels. In the Holey Land WMA, the frequency of low water periods increased from nine events in Alternative 2 to 13 events in Alternative 3. In Rotenberger WMA the frequency of low water periods increased from 11 to 17 events between Alternatives 2 and 3, although average duration showing a slight decrease (from eight to seven weeks). Note that the recommendation for Alternative 2 had been to reduce depths in these areas without increasing the frequency of extreme low water. Rotenberger exceeds 1.5 ft 10% of the time (16 events averaging nine weeks each), whereas NSM exceeds the criterion 8% of the time (17 events averaging seven weeks). Holey Land exceeds 1.5 ft 17% of the time (24 events averaging 11 weeks), whereas NSM exceeds the criterion 15% of the time (19 times averaging 12 weeks). Both areas, however, are greatly improved over the 2050 Base. Water depths were decreased as were the frequency of high water events.

Performance Measures Used (Indicator Regions 28 and 29):

1. Inundation Duration. Mean hydroperiod, number of inundation events, and mean duration of inundation were compared for match with NSM values.
2. Extreme High Water (protection of upland refugia and tree islands). The frequency and duration of events in which depths exceeded 1.5 ft were calculated, with a planning target of zero exceedences of the criterion.
3. Extreme High Water (NSM flood levels). The frequency and duration of high-water periods in which depths exceeded NSM values were calculated, with a planning target of zero exceedences of NSM values.
4. Extreme Low Water (protection of peat soils). The frequency and duration of events in which depths fell below -1.0 ft were calculated, with a planning target of zero exceedences of the criterion.
5. Extreme Low Water (NSM low water levels). The frequency and duration of low-water periods in which depths fell below NSM minima were calculated, with a planning target of zero exceedences of NSM values.

Performance Indicators Used:

1. Normalized Weekly Stage Hydrograph for Indicator Regions 28 and 29
2. Temporal Variation in Mean Weekly Stage for Indicator Regions 28 and 29
3. Inundation Pattern (1965 - 1995) for Indicator Regions 28 and 29
4. Stage Duration Curves for Indicator Regions 28 and 29

Recommendations:

In Rotenberger WMA, minimize events the events that exceed the 1.5 ft criterion and decrease frequency of high stages. In both WMAs, these changes should not cause an increase in the frequency of drying below -1.0 ft.

Subteam Issues

The confidence level of extreme high water criterion for Holey Land (1.5 ft) needs to be examined. For both WMAs, determination needs to be made as to the appropriate planning target. The existing target is zero however consideration needs to be given to using NSM targets for future alternative evaluations.

WCA-3A

Performance Based Comments:

In general, Alternative 3 shows improvement over Alternative 2 in northern WCA-3A. Average annual hydroperiods for Indicator Regions 20 and 22 increased from 89 to 90 % and from 92 to 93 % respectively. This is very close to matching the NSM target (94%). The frequency of marsh dry-outs is still greater than NSM within Indicator Regions 20 and 22 and greater than the target of zero. In Region 21, there were 11 low water events compared to NSM's 17 events; however, it is desirable to minimize extreme drying in this region to protect peat soils from further oxidation and soil subsidence.

In south-central WCA-3A (Indicator Region 17), the average hydroperiod of Alternative 3 (88%) matches NSM. However, in Region 17 the NSM hydroperiod appears to be too short for a ridge and slough landscape (89%); thus by matching NSM, Alternative 3, like Alternative 2, tends to over-drain this area.

In Alternative 3, Indicator Region 14 depths (southern WCA-3A) exceed the high water criterion (2.5 ft) on ten occasions for an average of eight weeks per event, whereas NSM exceeds 2.5 ft only once for three weeks. This is a slight increase in percent of time compared to Alternative 2. During the 1994-95 high water period, Alternative 3 had sustained depths of 3-4 ft in Region 14, whereas NSM exceeded 2.5 ft only briefly in 1994. Although this is an improvement over the 2050 Base and over Alternative 2, it is a major restoration concern because of potential damage to tree islands. Similar but less extreme flooding happens throughout WCA-3A (All Indicator Regions except 22).

Performance Measures Used (Indicator Regions 14 and 17-22):

1. Inundation Duration. Mean hydroperiod, number of inundation events, and mean duration of inundation were compared for match with NSM values.
2. Extreme High Water (protection of tree islands). The frequency and duration of events in which depths exceeded 2.5 ft (or 2.0 ft, Indicator Region 21 only) were calculated, with a planning target of zero exceedences of the criterion.
3. Extreme High Water (NSM flood levels). The frequency and duration of high-water periods in which depths exceeded NSM values were calculated, with a planning target of zero exceedences of NSM values.

4. Extreme Low Water (protection of peat soils). The frequency and duration of events in which depths fell below -1.0 ft were calculated, with a planning target of zero exceedences of the criterion.
5. Extreme Low Water (NSM low water levels). The frequency and duration of low-water periods in which depths fell below NSM minima were calculated, with a planning target of zero exceedences of NSM values.
6. Timing of high and low stages. The weeks in which annual average high water and annual average low water occurred were compared to NSM, with a planning target of matching NSM timing.

Performance Indicators Used:

1. Normalized Weekly Stage Hydrograph for Indicator Regions 14,17-22
2. Temporal Variation in Mean Weekly Stage for Indicator Regions 14,17-22
3. Inundation Pattern (1965 - 1995) for Indicator Regions 14,17-22
4. Stage Duration Curves for Indicator Regions 14,17-22
5. Stage Duration Curve at Gage 3A-4
6. Ponding Depth Maps
7. Ponding Depth Difference Maps
8. Peak Stage Difference Maps

Recommendations:

Although it may not be possible to “drought-proof” northern WCA-3A, there is a need to decrease the number and duration of low water events to protect already impacted peat soils. An increase in dry season inputs of water into western WCA-3A and/or increase storage to north would be recommended.

There is a need to increase depths in Region 17 (central WCA-3A) by about 0.2 ft in the dry season and 0.5 ft in the wet season. The following recommendation is supported by the AET: adjust NSM trigger at 3A-4 gage to reflect more NSM-like (ridge and slough) conditions.

The elimination of extreme high water during 1994 and 1995 simulation periods would prevent negative impacts to tree islands. This is of concern since there is evidence that it takes no more than a single sustained high-water event to do major, and possibly lasting, damage to tree islands. There is an evident need for better conveyance of water to the south during high flow periods; it may also be necessary to increase northern storage in order to attenuate flood waters before they enter the Everglades system. The subteam recommends the removal of impediments to flow and/or to capture flood waters.

WCA-3B

Performance Based Comments:

Water levels have improved in Alternative 3 compared to Alternative 2 in WCA-3B. The high water criterion (2.5 ft) was exceeded eight times in Alternative 3 for an average duration of nine weeks compared to 13 events in Alternative 2 with an average of ten weeks per event. This more closely matches NSM conditions (six events averaging

six weeks), although is still much greater than the planning target of zero. The average annual hydroperiod for WCA-3B (99%) overshoots the NSM target of 94%.

Performance Measures Used (Indicator Region 15):

1. Inundation Duration. Mean hydroperiod, number of inundation events, and mean duration of inundation were compared for match with NSM values.
2. Extreme High Water (protection of tree islands). The frequency and duration of events in which depths exceeded 2.5 ft were calculated, with a planning target of zero exceedences of the criterion.
3. Timing of high and low stages. The weeks in which annual average high water and annual average low water occurred were compared to NSM, with a planning target of matching NSM timing.

Performance Indicators Used:

1. Normalized Weekly Stage Hydrograph for Indicator Region 15
2. Temporal Variation in Mean Weekly Stage for Indicator Region 15
3. Inundation Pattern (1965 - 1995) for Indicator Region 15
4. Stage Duration Curves for Indicator Region 15
5. Ponding Depth Maps
6. Ponding Depth Difference Maps
7. Peak Stage Difference Maps

Recommendations:

WCA-3B needs to be shallower. Specific recommendations are to further reduce peak depths in northern WCA-3B, and to reduce average wet season highs in the region. The recommended way to achieve this is to provide appropriate and abundant conveyance of water from the conservation areas to ENP in such a manner that NSM depths can be achieved in Shark Slough without leading to excessive ponding in WCA-3B or over-drainage of WCA-3A.

Overall Northern and Central Everglades - Landscape-level Evaluation

Performance Based Comments:

There is more connectivity of dry-season refugia in Alternative 3 than in other alternatives, but it is still less than NSM. A smaller proportion of the overall system has ponding (deep-water refugia) in 1-2 ft range than does NSM. Dry season refugia in WCA-1, WCA-2A, and WCA-3A occur along levees, as in the other alternatives and bases; however, WCA-1 is more like NSM in Alternative 3 than in other alternatives. Dry-season refugia in WCA-2A and -3A are restricted to levees edges and are disconnected from each other. This may reduce the area of marsh that aquatic organisms can disperse to after seasonal re-wetting. In WCA-3B, Alternative 3 has a larger area of dry-season refugia than other alternatives but peak stage differences when compared to the 1995 Base show increased risk of flooding tree islands.

Performance Measures Used:

1. May ponding depth maps

2. Peak stage difference maps

F. Southern Everglades (Everglades National Park, Model Lands)

Southern Everglades (Everglades National Park, C-111 Basin, Model Lands)

Northeast Shark Slough

Performance Based Comments:

Under Alternative 3, the majority of overland flows are still shunted to the west rather than into the slough. Alternative 3, like Alternative 2, approaches, but still falls short of, NSM. Alternative 3 resulted in water depths that were lower, overall, than NSM. Under Alternative 3, the number of drydowns in NESRS is six times greater than predicted by NSM. This frequency of drydowns in the heart of the historic Shark Slough will continue to demonstrably lower standing crops and alter community composition of fishes and aquatic invertebrates and to cause loss of peat soils. *Melaleuca* expansion will continue to progress westward into the slough because of overdrainage, resulting in shorter hydroperiods.

For Indicator Region 11, the number of weeks water depths exceed 2.1 ft is about twice as great under NSM than Alternative 3, whereas the number of weeks depths are lower than -1 ft is only slightly greater under Alternative 3 (one week) than NSM (zero weeks). Compared with previous alternatives, Alternative 3 comes closest to meeting the natural variability in water depths predicted under NSM.

Under Alternative 3, wet season stage (Indicator Region 11) approaches NSM, an improvement over Alternative 2, but falls short of NSM during the dry season, perhaps a result of water storage upstream.

Recommendations:

Reduce the number of drydowns. Incorporate seepage control strategies, such as buffer lands, sufficient to restore NSM-like conditions in Northeast Shark River Slough.

Shark River Slough

Performance Based Comments:

In a dry year, NSM predicts a persistent pool aligned along the main stem of the historic Shark Slough in accordance with natural topographic contours. The cessation of sufficient overland flow into Shark Slough has resulted in the reduction or elimination of persistent pooling, as well as increased frequency of drydowns, affecting survival and productivity of aquatic organisms. Hydroperiods and flows predicted by Alternative 3 were lower than NSM. Under Alternative 3, Shark Slough is drier 1-2 months longer than under NSM, with stage duration at three of five gages showing lower values than NSM.

For Indicator Region 10, the number of weeks water depths exceed 2.1 ft is about twice as great under NSM than Alternative 3, whereas the number of weeks depths are lower than -1 ft is only slightly greater under Alternative 3 (seven weeks) than NSM (zero weeks). Compared with previous alternatives, Alternative 3 comes closest to meeting the natural variability in water depths predicted by NSM.

Average monthly and annual overland flows to ENP show higher volumes of water going south of the Tamiami Trail under Alternative 3 when compared with Alternative 2. Under Alternative 3, flows west of the L-67 extension canal match those predicted by NSM, an improvement over Alternative 2, but overshoots NSM in the wet season.

Recommendations:

Rainfall-based flows must extend from the upper to the lower reaches of the Everglades catchment area in sufficient volume to maintain dry season pool formations that persist within the downstream reaches of the system, with hydro patterns similar to those predicted by NSM. The ADT should explore using the lowest management intensive strategy to establish rainfall-based flows.

Marl Lands West of Shark River Slough (Indicator Region 46)

Performance Based Comments:

Under Alternative 3, stage duration is slightly less or equal to values predicted by NSM, with an increase in the number of drydown events.

Rocky Glades/Eastern Marl Prairies

Performance Based Comments:

Although Alternative 3, like Alternative 2, provided some improvement over the various base alternatives, it fell significantly short of restoration targets when compared with NSM. For example, at gage G-596, NSM predicts flooding of the area for 75% of the simulation period, whereas Alternative 3 shows almost no surface water for the same period. In addition, hydroperiods under Alternative 3 are 30-60 days shorter than NSM, although this is an improvement over Alternative 2. Ponding depth differences indicate no difference between Alternative 3 and NSM; however, stage duration curves are not in agreement with this output. Subsurface water levels during the dry season are significantly lower than predicted for NSM; this has serious consequences for solution hole refugia. Under NSM, temporal variability in stage at the beginning of the wet season is greater than that seen under the alternatives.

Recommendations:

Restoration needs to provide longer continuous hydroperiods, greater ponding depths, and more frequent occurrence of multi-year continuous inundation. NSM predicted relatively longer hydroperiods than the 1995 Base and all of the alternatives to date. Restoration of more natural hydro patterns in this area will result in a suite of ecological benefits for aquatic communities and endangered species.

Taylor Slough

Performance Based Comments:

There are no differences in ponding depths and average annual hydroperiods between Alternative 3 and NSM. The subteam questions the reliability of NSM output for Taylor Slough. According to stage duration curves, NSM predicts longer hydroperiods for northern Taylor Slough (gage TSB) than in areas further south (gage NP-207). The output provided for Taylor Slough was not adequate for the subteam to make an assessment of the alternative. Models runs for more stations within Taylor Slough are needed.

C-111 Basin

Performance: Based Comments:

Sheetflow must be reestablished in the C-111 Basin, including filling in canals, ditches, and culvert pools to reduce colonization opportunities by exotic organisms, and to eliminate artificially large, deep-water habitats that result in changes in species composition and energy flow in the adjacent wetlands. Alternative 3, like Alternative 2, shows that there nearly two times the number of drydown events in Indicator Region 4 as predicted by NSM. This increased frequency of drydowns has a substantial negative effect on the survival and productivity of aquatic organisms, and on associated ecological processes. Under Alternative 3, water management has eliminated the natural variability in dry season water levels apparent under NSM.

Recommendation:

Restoration strategies for the C-111 basin must reduce the frequency of drydown events as evident in Alternative 3.

Model Lands

Performance Based Comments:

Under Alternative 3 and base conditions, water depths and hydroperiods in Indicator Region 6 are less than half those predicted by NSM. The natural variability in stage is also eliminated under Alternative 3. All model simulation alternatives, including Alternative 3, demonstrate that the Model Lands remain hydrologically isolated, producing conditions that do not approximate NSM conditions.

Recommendation:

The basin is closed and ecologically degraded, lacking connection with adjacent wetlands to the west. The significant reduction in spatial extent of the historic natural system requires that efforts be made to restore these wetlands. Explore strategies to improve the timing and distribution of water deliveries to the Model Lands.

General Comments on Alternative 3 for the Central and Southern Everglades

Alternative 3 shows some improvements over Alternative 2 that move toward ecological restoration of the system. Alternative 3 approaches NSM in some performance measures, but generally falls short of NSM over most of the region.

In the 1984 memorandum that introduced the 7-Point Plan proposed by Everglades National Park, the major recommendations for hydrologic restoration of the Shark Slough Basin included the degradation of levees and filling of canals, establishment of a rainfall-driven system, and the reestablishment of sheet-flow. The ecological benefits of these hydrological actions included: (1) the reestablishment of connections between isolated basins to permit movement by aquatic animals, thereby reducing the isolation of populations; and (2) filling in canals and ditches to reduce colonization opportunities by exotic organisms, and to eliminate artificially large, deep-water habitats that result in changes in species composition and energy flow in the adjacent wetlands.

A general assessment of Alternative 3, like Alternative 2, indicated that a number of structures (e.g., curtain walls and new structures) have been added but, conversely, the beneficial activity of the removal of structures and canals was not evident.

Recommendation:

Alternative 3, like Alternative 2, did not appear to greatly advance the majority of hydrological restoration objectives promoted by the 7-Point plan, and subsequent documents. The subteam recommends that future alternatives incorporate modifications to address these concerns.

G. Estuaries and Bays

Please see the subteam's highlights report.

H. Big Cypress Subregion

In all cases targets were conditions predicted by the Natural System Model (NSM).

Performance Based Comments:

Annual Average Hydroperiod Differences relative to the NSM were generally similar among 2050 Base and all of the alternatives, but there were some important differences between them and the 1995 Base. In the 1995 Base, much drier areas were located in the westernmost 2-3 columns of the model, and along the northern boundary of the Big Cypress and the northeast corner of the Big Cypress region. The cells along the western boundary have a definite problem, probably associated with the NSM. NSM hydroperiods are way too long, given what we know about the area, so these columns have been excluded from most of the performance measures or evaluations. The drier northern boundary cells could have either a boundary problem or be an effect of upstream

alterations. Not enough is known about the area to sort out these possibilities at this time. The northeast Big Cypress is severely drained, probably because of the large canals in the area.

Annual Average Hydroperiod Differences relative to NSM in the non-1995 Base simulations were at most small along the southeast edge of the Big Cypress below Tamiami Trail. For the 2050 Base and Alternative 1, these differences are mostly drier. For the Starting Point and Alternative 2, these differences are scattered and are both wetter and drier. For Alternative 3, there are no differences in this area. In all of the non-1995 Base simulations, the drier conditions that extend southwest from the north end of L-28 to Tamiami Trail are more severely drier than in the 1995 Base simulation.

Relative to the 2050 Base, Hydroperiod Benefits / Impacts in the Big Cypress from the Starting Point, Alternative 1 or 2 scenarios were located in the southeast corner of the area and were minor and very scattered. In this same area overshoots occupy a large portion of the area, although they are of less than 30 days duration.

None of the three base or three alternative scenarios showed Ponding Depth Differences when compared to NSM conditions. The only exception might be along the southwest corner, which might be an effect of the Barron River Canal along Route 29 or more probably is an effect of being located along the model boundary. However, relative to the NSM, Ponding Depth Differences in the lower portion of WCA-3A along the preserve that are present in the 1995 Base, do not exist in the 2050 Base or any of the Alternatives. This would suggest that L-28 does not affect water levels under scenarios other than the 1995 Base.

Relative to NSM, there are some Frequency of Peak Stage Differences among the 2050 Base, Starting Point, and Alternative 1, 2, and 3 scenarios that are important to the Big Cypress. The differences along the western edge of the Big Cypress are probably model boundary effects. The major differences in the northeast corner indicate a much higher frequency of lower peak stages over a large area, probably associated with the large canals in this area. There is a large area where higher peak stages are more frequent in the western half of the Big Cypress between I-75 and Tamiami Trail. A possible explanation for this might be increased development of lands to the north with associated dumping of water during the wet season. In the vicinity of the north end of L-28, there is a small area where there is an increased frequency of lower peak stages. However, frequency of higher peak stages in the lower end of WCA-3A are much higher in the 2050 Base and all of the alternatives than in the NSM, while the adjacent area west of L-28 shows little change. This suggests an effect of L-28 that protects the Big Cypress just north of Tamiami Trail from unnaturally high peak stages in WCA-3A, while creating unnaturally low peak stages in the Big Cypress just west of the north end of L-28.

Relative to the 2050 Base, there are no Frequency of Peak Stage Differences in the Big Cypress among the 2050 Base-Sea Level Rise, Starting Point, and Alternative 1, 2, and 3 scenarios. Alternatives 1 and 3 make the south end of WCA-3A slightly drier and all alternatives make its north end slightly wetter, which should produce better

conditions adjacent to the Big Cypress and could reduce any effects L-28 may be having on Big Cypress water levels. The reduced frequency of lower peak stages in the south end of WCA-3A is not present in the Starting Point and Alternative 2. There is a slightly higher frequency of higher peak stages in the southeastern portion of the Big Cypress below Tamiami Trail.

Relative to the 1995 Base, there are no Frequency of Peak Stage Differences in the Big Cypress among the 2050 Base, Starting Point, and Alternative 1, 2, and 3 scenarios. The most important change has to do with the increased frequency of lowered water levels in the southern half of WCA-3A, which again reduces the influence of L-28 on Big Cypress water levels. This is primarily accomplished in the 2050 Base simulation, and is found in the Starting Point and Alternative 3 scenarios. There is some additional reduction in Alternatives 1 and 2. There is a small increase in frequency of slightly higher peak stages in the southeastern portion of the Big Cypress bordering the Everglades in the 2050 Base and all of the alternatives. There is also an increase in the frequency of higher peak stages along the northeast edge of the Big Cypress, in the vicinity of the large canals in this area.

Relative to the Starting Point, there were no Frequency of Peak Stage Differences in or near the Big Cypress for Alternative 3. Relative to Alternative 1, there were no Frequency of Peak Stage Differences in the Big Cypress for Alternative 3. However, the southern end of WCA-3A and the southeastern edge of Big Cypress were slightly wetter in Alternative 3. Relative to Alternative 2, there were no Frequency of Peak Stage Differences in the Big Cypress for Alternative 3. However, the southern end of WCA-3A and the southeastern edge of Big Cypress were slightly wetter in Alternative 3.

For the Big Cypress Indicator Regions reported on in Alternative 2, including those that were combined into larger units, there were no significant changes in hydrology from conditions in Alternative 2. With the exception of the two upland pines (Indicator Regions 32, 33) and West Slough (Indicator Region 13), for all of the preserve Indicator Regions, the non-NSM simulations were all similar to one another and water levels were lower than those in the NSM. The upland pine water levels were similar between all of the simulations including NSM. West Slough water levels were more variable among the simulations. The remaining Indicator Regions varied in being sometimes-to-consistently lower, and from slightly-to-much lower.

Those that were much lower were the two Indicator Regions 34 and 35 along the western boundary of the model. However, they, particularly region 35, are probably much lower primarily because of problems with the NSM hydroperiods being much longer than they should be in the westernmost two (three?) columns of cells, given what we know about the current and historic plant communities in these areas.

The upland pine Indicator Region 32 (new combined Indicator Region) showed no real differences among the simulations.

The Cypress Indicator Region 40 (new combined Indicator Region) south of Tamiami Trail showed little difference among the simulations, with only about a 4% reduction in hydroperiod.

The Indicator Regions along the eastern portion of the Big Cypress indicated differences between the NSM and all of the other simulations, specifically lower water levels than were predicted by the NSM. Hydroperiod reductions were on the order of up to 2 - 12% in this area. These sites were distributed from Mullet Slough (#31, #38, #39) south through Raccoon Point (#45) to the jetport area (#36, #37). The Mullet Slough sites could be affected by upstream activities or possibly backwater effects of water management in the WCAs. Water levels as predicted by the NSM and other simulations for Mullet Slough Indicator Regions 38 and 39 were more similar during the period 1980-93 than before or after this period. The management of the L-28 and adjacent WCA-3A could affect Raccoon Point and the jetport Indicator Regions.

Alternative 3 produced a very substantial improvement in matching the NSM water level regime in West Slough (Indicator Region 13). Looking at the stage duration curves, Alternative 3 water levels were consistently only slightly higher than NSM at the highest water levels. There was an excellent seasonal match between NSM and Alternative 3 water levels. In contrast to all of the other times when Alternative 3 tracked NSM water levels, the Alternative 3 drydown during winter-spring of 1972 and 1989 deviated noticeably from NSM and 1995 Base conditions, but was similar to 2050 Base and the other alternatives. Alternative 3 hydroperiods (66%) were also closer to NSM (65%) and 1995 Base (67%), than to the 2050 Base or any of the other alternatives, which varied from 72-74%.

Among the new Big Cypress Indicator Regions, with the exception of Upper Mullet Slough (Indicator Region 33) and Cape Sable Seaside Sparrow West (Indicator Region 46) water levels in all of the non-NSM scenarios tracked each other well-to-perfectly and were slightly-to-very much lower than NSM water levels.

As found for the nearby Upland Pine Indicator Region, water levels in scenarios for the Upper Mullet Slough Indicator Region 33 were all identical.

Water levels in all non-NSM scenarios tracked each other perfectly in the NW Big Cypress Indicator Region 41, NE Big Cypress Indicator Region 42, and SW Indicator Region 44. Non-NSM water levels were normally 0.1 - 0.3, 0.2 - 0.5, and 0.0 - 0.05 ft, respectively, lower than NSM water levels. They were most different when water levels were below ground during the fall-winter-spring drydown. Except for Indicator Region 44, hydroperiods were shorter in the non-NSM scenarios, 45% vs. 52% and 42% vs. 61%, respectively. Except for Indicator Region 44 where differences between non-NSM and NSM water levels were small, water level differences appeared to be more consistent and pronounced from 1965 through about 1979 than in subsequent years.

In the NE Corner of the Big Cypress Indicator Region 43, non-NSM water levels tracked each other well, with only a slight divergence at the lowest water levels. Non-

NSM water levels were almost always 1 - 2.5 ft below NSM water levels, and hydroperiods were reduced from 79% to 8-9% in the non-NSM scenarios. Again differences were more pronounced during drydown.

All scenarios tracked each other well when water levels were 0.5 ft or more above ground in Cape Sable Seaside Sparrow Indicator Region 46. When water levels dropped below 0.5 feet the scenarios began to diverge, with 1995 Base and Alternative 3 being slightly lower than NSM and 2050 Base and Alternative 2 being higher than NSM. When water levels were 1.5 ft below ground, Alternative 3 tracked NSM. The 2050 Base and Alternatives 2 and 3 tracked NSM well during the wet season and diverged through the dry season, when 2050 Base and Alternative 2 were slightly higher than NSM and Alternative 3 was slightly lower. Alternative 3 tracked NSM well through the late spring - early summer water level rise. The 1995 Base was distinctly lower during drydown and slightly higher during the water level rise period.

Cell R20 C13 is part of Indicator Region 13, and is adequately described above.

In Cell R17 C13 all simulations track each other well, although NSM water levels are frequently slightly higher, particularly when water levels are below ground. At higher water levels Alternative 3 is closer to NSM than are either of the two Base or the Alternative 2 scenarios, while at lower water levels it is farther from NSM than are the 2050 Base or Alternative 2 scenario.

As predicted by all base and alternative scenarios, hydroperiods in less than half of the North Big Cypress National Preserve matched NSM conditions. Most of these acres had 30-90 day shorter hydroperiods, but for about 10% of the acres, hydroperiods were 90-180 days shorter. There were no differences among any of the scenarios, indicating that none of the components were influencing this area.

In the South Big Cypress National Preserve there are small differences among the scenarios, but only about 10% of the area is different from NSM, and most of those deviations are only 30-90 days longer or shorter. The 30-90 day longer-than-NSM hydroperiods that appeared to be associated with the adjacent Everglades in earlier scenarios were eliminated in Alternative 3, while the shorter-than-NSM hydroperiods that appeared to be associated with the area southwest of the north end of L-28 had not changed.

Average overland flows to the Gulf of Mexico in the Big Cypress show substantial spatial variability, although within a geographic area, flows predicted by the various base and alternative scenarios were similar to one another but different from the NSM. In the western Big Cypress National Preserve, dry season flows were similar among all scenarios, except NSM which had about 50% more flow than the other scenarios during the wet season. In the eastern Big Cypress National Preserve both wet and dry season flows were about 50% higher in the NSM than all other scenarios. In the Lostman's area, next to the Everglades, flows are substantially higher among all base and alternative scenarios during both wet and dry seasons than for the NSM. There is also

more variability among the scenarios in the Lostman's area than for either of the other flow cross-sections, because of the greater amount of hydrologic manipulation in the Everglades than in the Big Cypress. Alternative 3 showed substantial improvement over Alternative 2 in returning both wet and dry flows to a condition more comparable to that seen in the NSM scenario. This was particularly evident in the period from January through August.

Performance Measures and Indicators Used:

1. Hydroperiod Distribution Maps
2. Hydroperiod Improvement Maps
3. Hydroperiod Differences Maps
4. Ponding Depth Maps
5. Ponding Depth Differences Maps
6. Peak Stage Differences Maps
7. Indicator Regions in or near Big Cypress (13, 31-46)
 - Weekly Stage Hydrographs
 - Weekly Stage Duration Curves
 - Temporal Variation of Stage
8. Big Cypress National Preserve
 - Cells R20 C13 and R17 and C13
 - Stage Hydrographs
 - Stage Duration Curve
 - North and South Big Cypress National Preserve
 - NSM and 50B hydroperiod matches
 - Average wet/dry season flows toward Gulf of Mexico
 - western Big Cypress National Preserve
 - eastern Big Cypress National Preserve
 - Lostman's
 - Average monthly overland flows toward Gulf of Mexico
 - western Big Cypress National Preserve
 - eastern Big Cypress National Preserve
 - Lostman's

Recommendations:

The effects of removing the L-28 levee would still be interesting to see, based upon the effects observed in Indicator Regions and overland flows along the eastern portion of the preserve. Also, given system changes to be made in the 2050 Base, hydroperiods, ponding depths, and peak stages in cells adjacent to the levee do not appear to be influenced by its presence after the 1995 Base scenario.

Try to determine what changes in system components and/or operations might reduce the large current differences in hydrology from that predicted by the NSM for the northeastern portion of the Big Cypress.

L Water Quality

Performance Based Comments:

In terms of mean phosphorus concentrations within the Everglades Protection Area (EPA), Alternative 3 appeared to create higher phosphorus concentrations in Water Conservation Area 3B (31-year mean) than either Alternative 2 or the 2050 Base condition. There are two possible reasons for this: 1) the volume of ground water retained in 3B is greater in Alternative 3 than in the other alternatives; since the ground water concentration modeled for WCA-3B is 30 ppb, increasing the ground water volume (or more accurately, not diminishing ground water volumes) could increase mean grid cell phosphorus concentrations; 2) there is an error in the model for calculating grid cell phosphorus concentrations in WCA-3B; Zhenquan Chen (SFWMD) is investigating this possibility.

For Everglades National Park, 31-year mean grid cell phosphorus concentrations were slightly higher in Alternative 3 compared to the 2050 Base and Alternative 2; however, all of the scenarios simulated had phosphorus concentrations below the target (10 ppb).

For the 14 internal marsh stations in Loxahatchee National Wildlife Refuge (WCA-1), 31-year mean grid cell phosphorus concentrations were slightly lower in Alternative 3 compared to the 2050 Base and Alternative 2. All of the simulated mean grid cell concentrations were significantly less (approximately 25%) than the long-term wet season target for LNWR per the Settlement Agreement (7 ppb). However, for the Refuge as a whole, Alternative 3 increased the 31-year mean phosphorus grid cell concentration slightly. This is probably due to switching the Refuge to a rainfall-driven schedule, which significantly increased inflows to the Refuge compared to previously simulated alternatives.

The team continues to caution that the main underlying assumption for this modeling effort is that the Everglades Forever Act (EFA) is fully implemented, and that all structural flows to the EPA contain total phosphorus at a concentration of 10 ppb (or less), including all new or increased flows resulting from Restudy components. Given this assumption, the team has not yet determined that the model has simulated ecologically significant differences between the 2050 Base conditions and any alternative plan evaluated to date. This principle assumption regarding the implementation of the EFA, while legally valid, further fails to clarify the land use and construction and operation costs and hydrologic demands of future treatment facilities necessary to achieve the requirements of the Everglades Forever Act. Furthermore, because of the multiple uses of several of the components (M3, 01, P2, S3, U3, V2), it is difficult to calculate the annual volumes of water discharged out of those components into the Everglades Protection Area. This calculation and underlying assumptions about phosphorus forms, concentrations, and loads are key to determining future treatment requirements. This information can be fully developed in future detailed design work if the components remain in the comprehensive plan and advance to design and construction; however, the team further cautions that lacking detailed information, it is difficult to accurately predict future treatment needs and attendant land-use conflicts and estimate capital and operation and maintenance costs

For Lake Okeechobee, Alternative 3 was approximately equivalent to Alternative 2 for all performance measures except wet season phosphorus out-loads (outflows from the lake). This is assumed to be a result of the increment of wet season volume in Lake Okeechobee directed to aquifer storage and recovery (ASR) facilities (1,000 MGD) around the lake included in this alternative. The team continues to note that lake eutrophication reversal is not expected to be observed during the 23-year simulation period for the model (1973-1995). This is due primarily to the existing in-lake nutrient loads and nutrient cycling processes. In-lake nutrient loads are not expected to diminish significantly during the model simulation period.

Performance Measures Used:

The team used performance measures and indicators developed for the South Florida Water Management Model, Everglades Water Quality Model, and the Lake Okeechobee Water Quality Model. Additionally, the Team prepared a summary table for this alternative showing the size of the plan components and the source of water delivered to each plan component, receiving water bodies for each component, classification and special status, ambient phosphorus concentrations (if known), and phosphorus treatment efficiency, as well as observations about the hydrologic characteristics of the components. A copy of the table appears at the end of this report.

Specific Performance Measures/Indicators Used:

South Florida Water Management Model

1. Stage Duration Curves and Stage Hydrographs for all of the reservoirs included in this alternative plan (North Reservoir, Taylor Creek/Nubbins Slough Reservoir, St. Lucie Reservoir, Caloosahatchee Reservoir, EAA Reservoir, Site 1 Reservoir, C-11 Reservoir, C-9 Reservoir, Central Lakebelt Reservoir, Bird Drive Reservoir).
2. Water budget data from FTP site.

Everglades Water Quality Model

1. Mean grid cell water column phosphorus concentrations within the Everglades Protection Area (EPA).
2. 14-station (per Settlement Agreement) mean phosphorus concentration within Loxahatchee National Wildlife Refuge.
3. Mean annual phosphorus load to the EPA.
4. Mean basin phosphorus concentration.
5. Combined flow-weighted mean phosphorus concentration at S12s/S333 (per Settlement Agreement).

Lake Okeechobee Water Quality Model

1. Lake Okeechobee volume.
2. Cumulative phosphorus loading into Lake Okeechobee.
3. Cumulative phosphorus load in discharges from Lake Okeechobee.
4. Phosphorus flux to sediments.

5. Difference from Future Base concentrations for total phosphorus, chlorophyll-a, and blue-green algae.
6. Box plot comparisons of total phosphorus, chlorophyll-a, and blue-green algae

Recommendations:

The storage reservoirs should be operated to optimally capture phosphorus contained in inflows and remove phosphorus from outflows. To the extent that phosphorus is a surrogate for other pollutants, optimal operation of these facilities for phosphorus removal will contribute to additional downstream pollution load reductions. The team's present recommendation for optimal operation is to maintain at least 2.5 ft depth in the reservoirs, with a minimum hydraulic retention time of 21 days prior to discharge upon re-wetting (when depths fall below 2.5 ft).

The modeling team should develop the previously-requested performance indicator summarizing average annual structural flows to the Everglades Protection Area from all sources, not just the Everglades Construction Project. The Water Quality Team views this as a particularly important indicator of potential water quality impacts associated with each alternative plan; such a performance indicator would also clarify potential land use conflicts and treatment costs.

The Water Quality Team recommends against switching Loxahatchee National Wildlife Refuge to a rainfall-driven regulation schedule. At this time, the potential adverse water quality impacts of such a change within the Refuge appear to outweigh the observed downstream hydrologic benefits.

Subteam Issues:

Restudy components must meet State and Tribal water quality standards, as appropriate. In particular, increased flows to the Everglades Protection Area (over that which is in the 2050 Base condition, i.e. Everglades Forever Act fully implemented) must meet the yet-to-be-established numeric phosphorus criteria for the EPA (default concentration = 10 parts per billion). The technology (and hydrologic demands, if any) required to achieve this standard has not yet been determined. Furthermore, it can be reasonably assumed that the technology (and concurrent land and hydrologic demands) will vary for Restudy components, depending upon location. Component design should continue to take into account current and future land uses in the vicinity of the components and the estimated land acquisition, construction, and operations costs to assure that water quality treatment facilities necessary to meet water quality standards are included in the final design.

Additionally, treatment costs may not be limited to just those necessary to achieve surface water standards. Restudy components capable of polluting groundwater (ASR, discharges in the vicinity of underground drinking water sources) must include treatment necessary to achieve ground water quality standards prior to introduction of discharges into the ground water.

The team does not expect to observe a recovery of Lake Okeechobee during the simulation period for the model(s). Therefore, the long-term benefits of treatment facilities and wetlands restoration in the lake watershed are not readily observable in the water quality performance indicators which are available to evaluate the affect of the Restudy on the lake. Although modeling results may lead the Restudy Team to empirically conclude that there are no water quality benefits achieved by including water quality treatment features in the Restudy components when compared to 2050 Base Conditions, the team intuitively concludes that such projects and facilities will have long-term water quality benefits beyond the planning horizon for the Restudy.

Although the team concurs with the method for determining mean phosphorus concentration values in the Taylor Creek/Nubbin Slough basin (528 ppb), additional information is needed about the design and operation of the STA proposed for that basin. While it is understood that more detailed information about the design and operation of this component would occur in future detailed design work if this component is included in the final comprehensive plan, it is noted that the STA is assumed to achieve an 80% reduction in basin loads and concentrations prior to discharge to Lake Okeechobee (this efficiency is at the upper end of the range of phosphorus reduction efficiency for STAs).

Furthermore, the team has not determined that 107 ppb is the correct target concentration for discharges to Lake Okeechobee (this concentration will not necessarily contribute to a reduction of ambient lake water column phosphorus concentrations below the current mean concentration of approximately 100 ppb). Additional treatment works may be necessary to achieve target concentrations.

Components K2, X3, and Y3 involve increasing the amount of water contained within the West Palm Beach Water Catchment Area. This involves collecting runoff from the L-8, C-51, and C-17 watersheds (Class III waters), and directing it via the M-Canal and C-18 Canal to the Catchment Area. The C-18 Canal, M-Canal, and the Catchment Area are all Class I waters. To receive water quality certification under the Clean Water Act, Restudy components which create new surface waters discharges into Class I waters would have to discharge water of sufficient quality to assure that the Class I use classification is maintained. To further evaluate future treatment requirements, if any, ambient pollutant loads and concentrations within the watersheds would have to be quantified and compared against minimum, general, and Class I surface waters criteria contained within Florida Administrative Code Rule 62-302.

The team is concerned about changing Loxahatchee National Wildlife Refuge from the preferred regulation schedule to a rainfall-driven operating schedule (Component JJ3). This change resulted in an increase in the volume of water delivered to the Refuge from STA 1W from 163 k ac-ft (2050 Base condition, annual average) to 279 k ac-ft. For STA 1E, the increase was from 116.4 k ac-ft to 124.7 k ac-ft. Such a change would necessitate increasing the size of STA 1, which may not be technically feasible given the present design and adjacent land use. Alternatively, an additional STA would have to be built to accommodate the increased volume delivered from Lake Okeechobee. Neither scenario, however, is preferred. Presently, the interior of the Refuge is “isolated”

from EAA flows (including future flows delivered by STA 1) by the surrounding canals and the current regulation schedule. Increasing the volume of flow delivered from Lake Okeechobee to achieve rainfall-driven operations and forcing that water over the marsh to achieve NSM hydrologic targets may possibly cause deleterious ecological affects. Specifically, STA-treated water has a different pH and conductivity than interior marsh water. Subtle chemical changes to the water delivered to the interior marsh may cause changes in the trophic structure of the Refuge marsh.

Components D2 and GG3 involve storing Lake Okeechobee and Caloosahatchee River watershed runoff in 122 10 MGD aquifer storage and recovery (ASR) wells, creating a total of 1,220 MGD of surface water to be injected and stored in the Floridan aquifer. No treatment is assumed prior to injection. The team has not yet determined that this is a reasonable assumption. In fact, under present regulations, any water which is to be injected into an underground source of drinking water must generally meet all primary and secondary drinking water standards at the point of injection. In addition to the primary and secondary drinking water standards, FDEP has promulgated guidance concentration criteria for a number of compounds, including some pesticides which have been detected in South Florida. Furthermore, the potential ecological impacts of using water recovered from an aquifer for environmental enhancement purposes (both direct and indirect) have not been evaluated. The team is concerned about the affect of temperature differences on the chemical composition of the recovered water, differences in pH, low dissolved oxygen, and the potential for increased mercury methylation in recovered injectate. If these component remain in the comprehensive plan, the costs to design and construct treatment works (including land acquisition, if necessary) necessary to treat surface water to drinking water standards or to lake or river-ready conditions (for ecological enhancement purposes) would have to be included in the comprehensive plan.

ALTERNATIVE 3 COMPONENTS WQ ANALYSIS

Error! Bookmark not defined. Error! Bookmark not defined. Component	Error! Bookmark not defined. Source Water	Error! Bookmark not defined. Class Error! Bookmark not defined. OFW	[P] ppb	Error! Bookmark not defined. Receiving Water	Class OFW	[P] ppb	Storage Volume	Treatment Efficiency/Regulatory Reqs	Notes Error! Bookmark not defined. Hydrologic Performance
A3 N. Res.	Lake O. Kiss. WS (?)	I/III N	?	Lake O.	I N		200,000 af	?	Dry 75% of time
B2 St. Lucie Res.	Lake O. St. L. WS	I/III N	100 ?	St. Lucie River	III N		40,000 af	?	Below 2 ft. 85% of time; dry 50% of time.
C1 St. Lucie Est. Deliveries	Lake O. St. L. Res.	I/III N	100 ?	St. Lucie Estuary	II/III Y			0 (Lake O.) ? (res.)	
D3 Caloos. Res.	Lake O./ Caloos. WS	I/III N	100 ?	C. River	I/III Y		160,000 af	C. Riv. In Lee Co. is Class I	Below 2 ft. 50% of time; dry 30% of time.
D3 Caloos. ASR	Lake O. Caloos. WS	I/III N	100 ?	C. River (estuary)	I/III		70% of 220 MGD = 172,914 af	0 any treatment prior to ASR?	UIC regs apply to ASR. Multi-year capability.
E1 Caloos. Est. Deliveries	Lake O. Caloos. Res.	I/III N	100 ?	Caloos. Estuary	III/II Y			0 (Lake O.) ? (res.)	Alt 3 deliveries close to target.
F3 Lake O. Reg Schedule	Lake O.	I	100	St. L & Caloos. Rivers, EAA, WCAs.	I/III			0	No add'l WQ Benefits assumed from Reg. Schedule
G3 EAA Res.	Lake O EAA runoff	I/III/IV(?) N	100 120	WCA 3 (via STA 3/4)	III/I V N	10	1 @ 20,000 af <u>1 @ 40,000</u>	?	Local = > 2 ft. 70% of time; Glades

							af 360,000 af		= < 2 ft. 90%+ of time.
H1 E'glades Rain-driven Operations	ECP/ STAs	III N	10	WCAs	III Y	10		N/A	Need to know increased volume to calculate treatment area size and cost.
I3 WCA3B/ ENP Improved Conveyanc e	WCA 3B	III N	10	ENP	III Y	10		N/A	Changed S- 355s to pumps, Bridging Tamiami Trail

Component	Source Water	Error! Book mark not defined. Class OFW	[P] ppb	Receiving Water	Class OFW	[P] ppb	Storage Volume	Treatment Error! Bookmark not defined. Efficiency/Regulatory Reqrments	Notes Hydrologic Performance
J									Not in Alt. 3
K2 L-8 Project	L-8 Basin, C-51 Basin, C-17 Basin	III N	?	M Canal, WPB CA Lox. Slough	I Y		Need to know this amount.	?	
X3 C-17 B'pumping	C-17 WS	III N	?	M Canal, WPB CA (via STA)	I		2,200 af (Alt 2 = 1,224 af)	?	No hydrologic specs on STA; STA must achieve Class I wqs
Y3 C-51 B'pumping	C-51W WS	III N	?	WPB CA	I		2,400 af (Alt 2 = 7,200 af)	?	No hydrologic specs on STA; STA must achieve Class I wqs.
L3 Coastal Wellfields	GW							N/A	Operational change; includes Riviera Bch., Dania, Miramar, Broward Co. 3A. GW regs. apply.
M3 Site 1 Res.	Hills. Canal	III N	?	Hills. Canal WCA-2A	III N	? 10	9,360 af	?	How much to WCA-2A? Res. below 2 ft. 55% of time.
M3 Site 1	Hills. Canal	III N	?	Hills. Canal	III N	?	25 MGD 19,600 af	Injected water	100 % recovery

ASR								must meet primary drinking water stds.	assumed.
N2 WCA-2B Levee Seepage Management	WCA 2B	III N	10	N/A	III N	10	N/A	N/A	Levee seepage reduction only.
01 WCA-3A/B Levee Seepage Management	WCA-3A/B	III N	10	WCA-3A/B	III N	10		N/A (?)	Buffer marsh seepage wq = WCA seepage wq? Buffer adj. to U.S 27.

Component	Error! Bookmark not defined. Source Water	Error! Bookmark not defined. Class OFW	[P] ppb	Receiving Water	Class OFW	[P] ppb	Storage Volume	Treatment Efficiency/ Regulatory Requets	Error! Bookmark not defined. Hydrologic Performance
P2 NNR Div. Canal & C-11 Treatment Fac.	NNR WCA-2B	III N	? 10	WCA-3A	III N	10	6,400 af Need to know vol. of NNR water not orig. in WCA2B.	Minimal if operated as indicated by stage duration curve. ?	Res below 2 ft. 80% of time; dry 10% of time.
Q1 WC-11 Diversion Canal	WC-11 WS	III N	?	Lakebelt Res.	III N Y (ENP)			N/A	Component of WC11 water to be delivered to L-30/NESRS via Lakebelt Res.
R3 C-9 Res.	WC-9 WS	III N	?	Lakebelt Res. (no direct discharge to C-9 from res.)	III N	11	10,000 af	Backpumping to WCA-3A?	Res. below 2 ft 65% of time. C-9 res. does not discharge directly to E'glades; dry 40% of time
S3 Lakebelt Res.	NNR WC-11 WC-9 C-6 C-7	III N	?	L30/NES RD-B Lev. Canal S.Creek Canal C-6, C-9	III N Y(ENP)	? 11	4,000 ac. reservoir; differential draw-downs between 7.5 and 25.0; up to 100,000 af	TP reduced from 50 to 40. Impacts on NW Wellfield (?). Limestone filter (?)	1200 ac STA; Res. below ground level 30% of time.
T1 C-4 Structure	C-4	III N	N/A	C-4	III N		N/A	N/A	WCA-3B Seepage control
U3 Bird Drive	WC-4 WS	III Y(L-	? 10	C-4 Seepage	III N	?	11,508 af Need to	Seepage of adequate	Below ground/dry

Res.	L-31N	31N)		to L-31N via S-356s	Y(ENP)	10	know what component is of lower wq	wq?	95% of time. Less water than Alt 2 in res.
FF3 S-356 A&B	L-31N (Bird Dr. Res.)	III N	?	ENP	III Y	11	N/A	Direct discharge to ENP; treatment adequate/n ecessary?	

Component	Source Water	Error! Bookmark not defined. Class OFW	[P] ppb	Error! Bookmark not defined. Receiving Water	Class OFW	[P] ppb	Storage Volume	Treatment Error! Bookmark not defined. Efficiency/Regulatory Reqmets	Notes Hydrologic Performance
V2 L-31N Levee Seepage Mgt.	ENP	III Y	10	ENP	III Y	10	N/A (backpump wet season seepage)	N/A	
W2 T. Creek/ N. Slough Res/STA	T.Creek N. Slough WS	III N	528	Lake O	I N	100	50,000 af	528 - 107 ppb. Is this reasonable based on size, conc., & load?	100% of runoff less than 50,000 af treated in STA. Res dry 70% of time (STA dry? = P source)
AA3 Add'l S-345s	WCA-3A	III N	10						

Component	Error! Bookmark not defined. Source Water	Class OFW	[P] ppb	Receiving Water	Class OFW	[P] ppb	Storage Volume	Treatment Efficiency/Regulatory Reqs	Error! Bookmark not defined. Hydrologic Performance
BB3 D-B Levee Seepage Control (Levee Impr.; Incr. Conv. Cap. of Canal)		III N	?	NW Wellfield	III (recharge canal) GW/DW	?	N/A	Treatment requirements to add incr. surface water to wellfield recharge canal?	Lakebelt STA adequate to treat to GW/DW stds.?
CC3 Broward Co. Canals	Basin runoff	III N	?	Canals, wellfields	III GW/DW	?	Quantify increased amount?	N/A	Increase canal sizes to recharge wellfields.
DD3 Holey Land Rainfall Operations	Lake O, Runoff, Rotenberger via STA 5/6	I III N Y	100 10	Holey Land WCA-3A via HPR features of ECP	III N	10		Lake O. deliveries treated via STAs?	Need to know how much more Lake O. water is sent to ECP to provide Rainfall deliveries.
EE3 Rotenberger Rainfall Operations	STA 5	III N	10	Rotenberger; HoleyLand	III Y	10		Dry-out implications for STA?	Increase in volume delivered by STA 5? Is capacity there?
GG3 Lake O ASR	Lake O	I N	100	Lake O	I N	DW	1,000 MGD 784,000 af	Fecal coliforms? Treatment required? Costs can be estimated?	More water available to lake during dry times.
HH3 S-343A &	WCA 3A	III N	10	ENP	III Y	10	N/A	N/A	Operated to minimize

B Operational Change									CSSS Impacts.
II3 G-404 Modification	STA 3/4	III N	10	WCA 3A	III N	10	N/A	Increased pumping to achieve HPR Goals.	Any dry-out impacts in STA?
JJ3 LNWR Rainfall Schedule	Lake O through h STA 1W	III N	10	LNWR	III Y	10	N/A	Impacts to design of STA 1E/W (phases 1 & 2)?	114 k ac. ft./yr more water into LNWR.

Component	Error! Bookmark not defined. Source Water	Class OFW	[P] ppb	Error! Bookmark not defined. Receiving Water	Class OFW	[P] ppb	Storage Volume	Treatment Efficiency/Regulatory Requirements	Error! Bookmark not defined. Hydrologic Performance
KK3 LNWR Internal Canal Structures	LNWR	III Y	10	LNWR WCA-2A	III Y N	10	N/A		Structures added to achieve hydrologic targets.
LL3 C-51 ASR	C-51 WS	III N	? coli - forms?	C-51	III N	DW	170 MGD 133,200 af Injection into unconfined aquifer.	Treatment required?	70 % recovery assumed
MM3 Hillsboro Canal ASR	Hillsboro Canal	III N	? coli - forms?	Hillsboro Canal	III N	DW	185 MGD 145,040 af	Treatment required?	70 % recovery assumed
NN3 NNR ASR	North New River Canal	III N	? coli - forms?	North New River Canal (E. Broward Co.)	III N	DW	125 MGD 98,000 af	Treatment required?	70 % recovery assumed
OO3 Phase II of Exp. Program	C-111 Basin, L-31W	III N	?	ENP via S-332D into L-31W	III Y (ENP)	10	N/A		Potential water quality impacts assoc. with increased dry-season flows from C-111 Basin to ENP.
PP3 C-7 Basin B pumping	C-7 Basin	III N	?	C-6 Canal to Lakebelt Res.	III N	?	N/A	N/A	Water quality impacts associated w/ C-7 water?
Total Available									Alt 2 = 988,606 af

Storage, Alt 3							2,304,622 af		
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1 ac. ft. = 325,851 gallons; 1 MGD = 3.07 ac. ft.; 1 MGD annual volume = 1,120 ac. ft.

LEGEND:

WS = Watershed	Y = Yes
ASR = Aquifer Storage & Recovery	N = No
ECP = Everglades Construction Project	W = West
STA = Stormwater Treatment Area	WCA = Water Conservation Area
WPB CA = West Palm Beach Catchment Area	CSSS = Cape Sable Seaside Sparrow
D-B = Dade-Broward Levee	af = acre feet

I. ATLSS / Threatened and Endangered / Keystone Species

Performance Based Comments:

The first individual-based ATLSS simulation is now available for the western subpopulation of the Cape Sable seaside sparrow. For other Cape Sable seaside sparrow subpopulations, wading birds and white-tailed deer, ATLSS outputs for Alternative 3 continue to be limited to Breeding Potential Indices (BPIs). Outputs on total fish abundance and fish prey base for wading birds are also available. Differences in input data make quantitative comparisons of Alternative 2 and Alternative 3 outputs to Alternative 1 outputs and/or 1995 Base outputs impossible and makes qualitative comparisons questionable. New performance indicators for Cape Sable seaside sparrows and American crocodiles are also addressed.

Performance:

Fish - The ATLSS fish model predicts that, due to overall wetter conditions in WCA-3B and south of Tamiami Trail, Alternative 3 hydrologic conditions will produce average fish abundances consistently higher than those expected for 2050, particularly in Shark River Slough and WCA-3B. This is also true when only prey-sized fish at appropriate wading bird foraging depths are counted. Exceptions occur in East Slough and South Big Cypress, where Alternative 3 produces slightly lower fish densities than the 2050 Base. Alternative 3 results are very similar to Alternative 2, with very slightly higher fish abundance for Alternative 3.

Wading Birds - Consistent with the fish model output, Alternative 3 would result in a slight improvement in breeding potential for wading birds over those expected for 2050 in most years due to slightly dryer conditions in the WCAs and slightly wetter conditions south of Tamiami Trail, particularly in Shark River Slough and its peripheral wetlands. Alternative 3 is very similar to Alternative 2.

White-tailed Deer - Alternative 3 would slightly improve the generally poor breeding conditions for white-tailed deer in SE Big Cypress, SE and East Slough regions in ENP and in wetter portions of WCA-3A, central WCA-1 and northern WCA-2A as compared to the 2050 Base, particularly in years with average to above average rainfall. Alternative 3 would slightly decrease the very low breeding potential in central Shark Slough and other portions of the WCAs. For those few areas with high deer breeding potential (Long Pine Key and surrounding short hydroperiod marsh and NW Big Cypress), there is little difference between Alternative 3 and 2050. Overall, Alternative 3 produces slightly better deer breeding potential than Alternative 2.

Cape Sable Seaside Sparrow - On average, during the sparrow breeding season, Alternative 3 is dryer than the 2050 Base, NSM and Alternative 2. The 1995 Base produces dry conditions about three weeks earlier than Alternative 3 and re-floods the area about one week earlier than Alternative 3. For the western sparrow subpopulation, Alternative 3 produced improved breeding potential in the northern portions of this habitat, and slightly lower breeding potential in the southern portions as compared to the 2050 Base, with a net improvement for this subpopulation over 2050 and Alternative 2. For the core sparrow subpopulation, breeding potential is very slightly lower for Alternative 3 as compared to 2050, and Alternative 3 breeding potential is essentially indistinguishable from Alternative 2. For the eastern subpopulations, Alternative 3 produces lower breeding potential than the 2050 Base and slightly lower breeding potential than Alternative 2. However, the BPI model does not consider possible beneficial effects to eastern habitat areas due to reduced shrub cover and reduced fire frequency. The ATLSS individual-based sparrow simulation is applied only to the western subpopulation, and predicts persistence of this subpopulation under Alternative 3, with numbers dropping below 1,500 individuals three times. Under 2050, this model consistently predicts extirpation of the western subpopulation.

American Crocodile - In absence of performance measure outputs, inspection of available Florida Bay salinity outputs indicates reduced salinities under Alternative 3 that would correspond to increased crocodile habitat suitability as compared to the 2050 Base, 1995 Base, Starting Point, and Alternatives 1-2.

Performance Measures and Indicators Used:

1. Breeding Potential Indices for the Cape Sable seaside sparrow, white-tailed deer, and generalized wading bird guild.
2. Fish productivity model.
3. Indicator region 46 - Cape Sable sparrow west.
4. ATLSS Cape Sable seaside sparrow Individual-based Simulation.

Recommendations:

1. **Wading Birds** - Reduce the number of hydroperiod reversals (increase in water depth during a period of falling water depths) occurring during the December 15 to May 15 breeding period.
2. **Cape Sable seaside sparrow** - Any actions that would further decrease late wet season and dry season flows west of Shark River Slough, particularly in wet years, would further improve breeding potential for the western sparrow subpopulation. For the core and eastern subpopulations, slightly reduced dry season flows, consistent with NSM, would increase breeding potential while preserving expected beneficial effects to sparrow habitat due to improved NE Shark Slough hydroperiods. The WCA-3 decompartmentalization scenario produces even dryer conditions than Alternative 3 in the western sparrow area. Therefore, full or partial implementation of this scenario will likely further improve conditions for the western sparrow subpopulation.
3. **American Crocodile** - Increased flows to Florida Bay, particularly in dry years, would provide further improvements in crocodile habitat suitability.

Subteam Issues:

1. The new sparrow west indicator region shows that NSM predicts longer hydroperiods in the western subpopulation area that would lead to further declines in the sparrow BPI. These counterintuitive results could result from error in the elevation data used in the SFWMM, a mis-match of suitable habitat areas as defined in ATLSS vs. as defined by observations of sparrow breeding activity, or error in NSM. Subteam members will meet with ENP hydrologists before the next run to address the latter possibility.
2. The ATLSS group plans to join the fish model and wading bird BPI over the next few months, and will develop separate "wood stork" and "white ibis" models for the next run. This will address some criticisms of the wading bird model.
3. Can the white-tailed deer BPI be combined with exiting panther radiotelemetry data to get a rough index of the proportion of the panther's prey base that is predicted to be affected by the alternatives? The subteam suspects this will prove to be a small portion of the panther's prey base, but it would be a useful calculation if it can be done before May. The subteam will work on this.
4. Rob Bennett's reports that code has been written for an interim snail kite indicator. This indicator should be available by the end of January, in time for Alternative 4.